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Science Education

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Science Education

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Science Education

Devoted to the Teaching of Science in Elementary Schools,
Junior and Senior High Schools, Colleges and
Teacher Training Institutions

Volume 17 FEBRUARY, 1933 Number 1

The Teaching of Science in the Secondary Schools of the North Central Association*

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University of Michigan

The purpose of this investigation was to ascertain the actual conditions and practices existing with respect to the teaching of science in the secondary schools accredited by the North Central Association.

During the spring of 1930 an extensive questionnaire was sent to every teacher of science in the 2167 accredited secondary schools of the Association. Sets of blanks were returned from 1802 or 83.1 per cent of these schools; and from 5481 teachers of one or more classes in science in these schools. The range in percentages of accredited schools reporting was from 96.1 per cent for Michigan to 66.1 per cent for Oklahoma.

Grade Placement of Science Subjects. *Agriculture* was taught† in 738 or 41.6 per cent of these schools. This subject was found in all the grades from the seventh to the twelfth, although, on the whole, in those

* This article is a résumé of the findings included in a more complete report published in *The North Central Association Quarterly*, VI (March, 1932), 433-474.

† The conclusions from all of these data are stated in the past tense because the various conditions may have changed somewhat in the interval between the collection of these data and the publishing of this report.

schools in which registration in this subject was restricted to a single grade, agriculture was scheduled most often in the tenth.

Astronomy was found in only 22 or 1.1 per cent of the schools. It was distinctly an upper-grade subject.

Biology. *Elementary biology* was listed in the replies from 260 or 14.6 per cent, and *advanced biology* in the replies from 923 or 52.1 per cent of these schools.

In a large majority of the schools of every group the study of biology was restricted to pupils of a single grade, usually of the tenth, though not infrequently of the ninth, the eleventh, and, in sporadic instances, the twelfth. In certain schools of every group, however, the classes in biology were made up of pupils of more than one grade, usually of the tenth and eleventh or of the upper three grades.

Botany and zoölogy were listed, respectively, in the reports from 308 or 17.4 and 191 or 10.8 per cent of these schools. In general the placement of these subjects followed the practices indicated with respect to biology.

Chemistry was listed in the replies from 1,251 or 70.6 per cent of the schools. It seems likely, however, that both this percentage and the percentage for physics were somewhat smaller than they should be to represent the total percentages of schools offering these two courses. This statement appears true because in many small schools chemistry and physics are offered in alternate years. In some of these schools, therefore, either chemistry or physics may have been omitted in the reports because it was not being taught at the time the questionnaire was answered, although it actually had a definite place in the science curriculum of the school.

Chemistry was found to be definitely an upper-grade subject, since it was offered in the tenth grade in a negligible number of schools.

General science appeared in the science curricula of 1199 or 76.7 per cent of the schools. The fact, however, that general science is offered below the ninth grade in a considerable number of school systems organized on the 8-4 plan renders this percentage too small to indicate truly the extent to which that subject was taught in the cities represented by these schools of the Association.

Geology was offered in 55 or 3.1 per cent of the schools and these schools are located chiefly in the mountain states, Colorado and Montana. This subject was confined almost wholly to the eleventh and twelfth grades.

Hygiene was found as a separate subject in 399 or 22.5 per cent of the schools. In these, the subject had no definite placement; it was scheduled in all the grades from the seventh through the twelfth and was found with about equal frequency in all of these grades.

Physics appeared in the science curricula of 1,589 or 89.7 per cent of the

schools. Like chemistry, physics was found to be distinctly an upper-grade subject and its study to be limited almost wholly to pupils of the eleventh and twelfth grades.

Physiography was reported in the replies from 311 or 17.6 per cent of the schools; in these it was regarded chiefly as a subject for the upper-high-school grades.

Physiology appeared as a separate subject in the reports of 521 or 29.3 per cent of the schools. Almost exactly half of the schools reporting physiology, however, are located in Illinois, in which state one-half unit of physiology is required by law to be taught in all high schools. This subject seems to have no definite grade placement.

Miscellaneous courses. Sanitation was found in the curricula of three of the schools, while mining, household chemistry, metallurgy, bacteriology, applied science, qualitative analysis, elementary science and elementary physical science (as distinguished from the conventional general science), and photography were each found in the science curriculum of one school.

Summary. The data of this study indicate that only four science courses were found in a majority of these high schools. Further, although there were many exceptions within the various groups, on the whole these four subjects had a definite grade placement and may be said to have constituted, for the four-year high school at least, a definite sequence. This sequence included general science in the ninth grade, biology in the tenth grade, and physics and chemistry in the eleventh and the twelfth grades.

COURSES IN SCIENCE REQUIRED FOR GRADUATION. The numbers of years of science required for graduation ranged in the various schools from none whatever to six years. In 52.7 per cent, or in slightly more than half of the schools, one year was required, while in 30.0 per cent of the schools two years were required. All but 6.8 per cent required one or more years of science for graduation.

Practically every science course listed was a requirement in some school or schools. In those schools in which the requirement for graduation was more than a single year, there were nearly two hundred different combinations of required science courses. Most of these requirements were stated specifically, though in most schools some latitude of choice was allowed among several designated courses. In 7.9 per cent of the schools, however, the pupil was permitted to choose any course in science offered.

The four major courses,* namely, general science, biology, physics, and

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* In this report the term, "major courses," is used to designate the four branches of science which appeared most often in the science curricula of the schools; the term, "minor courses," is used to designate all the other branches of science named in the replies.

chemistry, were required more frequently than any of the others. Chemistry and physics were more often found listed among the required courses than biology, while these three "laboratory courses" were required somewhat more frequently than general science. Of the minor subjects, only hygiene, agriculture, botany, zoölogy, and physiology were in any cases given major emphasis; that is, were named first in the statement of required courses in science.

SALARIES.* The salaries which these science teachers received ranged from no actual money whatever, in the cases of 153 men and women who were teaching in parochial schools and who constituted 1.1 per cent of the men and 7.0 of the women reporting this item, to more than $4,500 for certain administrators who taught one or more classes of science, or for certain college and university teachers who combined teaching in a high school with teaching in a junior college or a university.

The smallest salary received by any full-time teacher of science was that of one woman who reported $720 for her year's work. Only .5 per cent of the women and .3 per cent of the men, or .4 per cent of all these teachers, received salaries of less than $1,000.

On the whole, the men were much better paid than the women, though there was found to be a considerable overlapping of the salary-ranges for the two sexes. The modal number of women teachers, 551 or 34.5 per cent, received between $1,251 and $1,500; the modal number of men, 776 or 21.5 per cent, received from $1,751 to $2,000. Exclusive of those in the "no salary" group, 41.0 per cent of the women teachers but only 11.5 per cent of the men teachers received salaries of less than $1,501; while 51.8 per cent of the men teachers and only 25.3 of the women teachers received salaries in excess of $2,000.

OFFICIAL POSITIONS. These teachers may be divided into three groups: those (86.8 per cent) whose primary occupation was classroom instruction (classroom teachers, heads of departments, supervisors, and critic teachers); those (8.5 per cent) whose major duty was administration (superintendents, principals, assistant- or vice-principals, and deans); and those (4.8 per cent) whose chief responsibility was the coaching of athletics. A more detailed analysis would increase the percentage of the last group at the expense of the first, since some of the heads of departments were also officially in charge of athletics and had as additional duties some teaching, while others had their activities divided between teaching and athletics, but gave "classroom teacher" as their official designation.

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* Because of reductions here and there during the past three years of economic depression, it seems likely that present salaries are, on the whole, somewhat lower than those here reported.

Nearly 29 per cent of the teachers responding to this item were heads of departments. An overwhelming majority of these department heads were men, though in the groups of largest schools the numbers of these men and women who were heads of departments were approximately equal. There were 51 different combinations of subjects included in these various departments. Most of these department heads had charge either of departments of science or of one or more branches of science, such as "physics and chemistry," or "biology and general science." A considerable number, however, were heads of departments which combined one or more branches of science with some other subject having a remote relation or no relation whatever to science. Among such were found "head of science and athletics" and "head of biology and French." There was evident also in these schools some tendency to assign the teaching of science not only to department heads but also to classroom teachers whose major interests and training, as judged from their official positions as named, were totally divorced from science. Thus 3.9 per cent of all the teachers of science were in a group which included heads of modern language, of English, of French, of Spanish, of Latin, of social science, of commerce and athletics, of mathematics, of physical education, and of history.

Teaching Experience. A substantial percentage of the teachers had had little or no previous experience in teaching and a still larger percentage had had meager experience or none whatever in teaching science. Thus, a combination of data shows that 13.0 per cent of the men and 14.7 per cent of the women had had less than two years of teaching experience, and that 17.8 per cent of the men and 25.3 per cent of the women had taught science less than two years. It should be noted, however, that 32.0 per cent of the men and 36.4 per cent of the women had taught for more than ten years, and that 24.7 per cent of the men and 24.7 per cent of the women had taught *science* for more than ten years.

The data further show that many of the teachers had taken up the teaching of science after they had had some experience in teaching other subjects; and that considerably more of the women than of the men were in this group; also that the shifting of the teachers from school to school had been even greater than the shifting of teachers from other subjects into science.

A considerable percentage of the teachers had had experience in teaching in the elementary school; not half of these teachers, however, had had experience in teaching elementary science.

A considerable number of these teachers had had experience in teaching in college, university, or normal schools, or were still engaged in teaching in higher institutions of learning.

Degrees. The percentages of men and women teachers holding corresponding numbers of degrees were fairly constant. Most of the teachers (76.2 per cent of the men and 78.3 per cent of the women) possessed one degree; most of the remaining teachers (19.4 per cent of the men and 17.1 per cent of the women) had two degrees. Only 2.7 per cent of the men and 1.6 per cent of the women had more than two degrees.

The number of men (1,707) who possessed the B.S. degree was approximately 94 per cent of the number (1,820) who held the A.B. degree; the number of women (640) possessing the B.S. degree, however, was only about 70 per cent of the number (916) possessing the A.B. degree. The number of the men (207) who had the M.S. degree was about 43 per cent of the number (441) who had the M.A. degree. The number of the women (84) who held the M.S. degree was about 47 per cent of the number (178) who possessed the M.A. degree.

It is interesting to note that a considerably larger percentage of men than of women were working toward higher degrees, despite the fact that a larger percentage of the men already possessed advanced degrees.

A negligible percentage of the teachers, only .6 per cent of the men and .3 per cent of the women, possessed the Ph.D. degree.

The 116 miscellaneous degrees included B.L., B.Chem., B.S.E., B.M.T., B.Arch., A.A., B.L., B.Ped., and B.U. One was listed merely as B.

It is very interesting and encouraging to note the large number of the teachers, 18.8 per cent of the men and 16.4 of the women, who possessed advanced degrees. It is gratifying, moreover, to note that 47.9 per cent, or nearly half of the men, and 33.3 per cent, or exactly a third of the women, were pursuing their studies toward advanced degrees.

The data further show about three-fourths of the men and women who were engaged in work toward higher degrees were studying in summer school; the rest were availing themselves of the opportunities afforded by correspondence courses, extension courses, residence work, and part-time work. A few were engaged only in work upon their theses.

Practice Teaching. An inspection of the replies on this item revealed the fact that only 4.9 per cent of the men and 10.9 per cent of the women had had practice teaching; therefore, 95.1 per cent of the men and 89.1 per cent of the women had not had practice teaching in the accepted connotation of this term. Of these latter groups 76.6 per cent of the men and 77.4 of the women had been permitted to substitute laboratory instruction in college for practice teaching.

Those who believe practice teaching to be a necessary part of the preparation of the teacher would vigorously condemn, on several grounds, the practice which, in the case of more than three-fourths of the men and

women in this group, permitted the substitution of experience gained as a laboratory assistant in college classes for practice teaching. They would do this believing that (1) the methods used in teaching college laboratory classes are unlike those used in laboratory classes in the high schools; the number of identical elements in the two situations, therefore, may not be sufficiently numerous to insure any considerable degree of transfer from the college-laboratory to the high-school-laboratory class; (2) there is unlikely to be much overlapping of the subject matter of the college and the high school courses in science unless it should be between freshman college-courses and high-school courses in chemistry; and (3) laboratory teaching is only a part of the teaching work of the high-school teacher of science and therefore practice secured only in laboratory-teaching is inadequate preparation for the wide variety of instructional activities in which the prospective science teacher must subsequently engage.

Those who believe that practice teaching is an essential part of teacher preparation will be glad, however, to note that a negligible percentage of the men and women (respectively .2 and .3 per cent) were permitted to substitute mere observation of teaching for actual participation in classroom teaching.

The data indicate further that 68.4 per cent of the men and 50.0 per cent of the women had had their practice teaching (or its accepted equivalent) in science. Also, that the practice teaching of the remaining 31.6 per cent of the men and of the 50.0 per cent of the women had been secured in a bewildering variety of subjects and subject combinations, more than sixty of which have not the remotest connection with science.

Professional Preparation. Sixty-seven and eight-tenths per cent of the men and 65.9 per cent of the women had had between 12 and 30 undergraduate hours of education. Moreover a considerably larger percentage both of men and of women had had in excess of 30 hours than had had fewer than 12 hours.

Forty-eight and one-tenth per cent of the men and 940 or 61.6 per cent of the women teachers of science had no graduate credits in education. Moreover 87.7 per cent of the men and 94.6 per cent of the women had fewer than 31 graduate hours in education. On the whole the men had had, on the average, a somewhat larger number of graduate hours than the women. As with the undergraduate hours, the average number of graduate hours per teacher tended, in general, to increase with the size of the school.

Subject-Matter Preparation of all Teachers of Science. Of the 3260 men and 1247 women who submitted data on this item only 64 or 2.0 per cent and 16 or 1.3 per cent, respectively, reported that they were teaching classes in science when they had had no previous preparation in

the subject matter of any branch of science. Moreover, eighty per cent of the men and 69.4 per cent of the women had had more than thirty undergraduate hours of preparation in the subject matter of science; also 34.1 per cent of the men and 36.0 per cent of the women had had more or less of graduate work in some branch or branches of science.

Subject-Matter Preparation of Teachers of Biology, Chemistry, Physics, and General Science. Of the teachers who reported this item, those who were teaching physics were, on the whole, less well-trained in subject matter than those who were teaching either biology or chemistry, since 50.5 per cent of the men and 61.1 per cent of the women teachers of physics reported fewer than eleven undergraduate hours of subject matter, while 22.2 per cent of the men and 13.5 per cent of the women teachers of biology, and 12.2 per cent of the men and 19.3 per cent of the women teachers of chemistry reported fewer than eleven undergraduate hours of subject matter. Also a larger percentage of men and women teachers of biology and chemistry than of physics had had more than twenty hours of undergraduate and of graduate hours of subject matter. On the whole, the women teachers of biology had had more undergraduate hours of subject-matter preparation than the men; the opposite was true with respect to the men and women teachers of chemistry and physics.

Most of these men and women teachers of general science had had more or less subject matter training in four or more branches of science; the modal number for the men was five and for the women was four. It must be remembered, however, that closely allied courses such, for example, as hygiene, sanitation and bacteriology, were listed by many teachers as separate branches of science and could not be considered otherwise in preparing these tabulations. Moreover, the subject-matter training of a considerable percentage of these teachers was inadequate, since it was too highly specialized and was not sufficiently well distributed among the branches of science included in the course material of general science. On the whole, the men teachers on this subject had a somewhat more widely differentiated training in the subject matter of science than the women.

Teaching Load of Teachers of Science. Nearly three-fourths of these teachers had schedules which included between twenty and thirty periods of teaching per week. There are no significant differences in the number of periods taught per week by teachers of the four major subjects.

Teaching Combinations. Each branch of science was found in teaching combination with almost every other subject; apparently no subject in the entire program of studies of the high school was too far removed from science to be combined more or less frequently with it. In general, but only to a somewhat limited extent, this condition was found to improve with the size of the school.

PERIODS PER WEEK DEVOTED TO SCIENCE. Although there was considerable variation in the number of periods per week provided for the four major branches of science, either five or seven periods per week were used in the majority of schools represented by the teachers' programs. Chemistry and physics were offered seven periods per week in, respectively, 57.0 and 58.9 per cent of the schools, while these same subjects were offered five times per week in, respectively, 36.9 and 34.9 per cent of the schools. This situation is reversed in the cases of biology and general science, for which there was a provision for five periods per week in, respectively, 49.4 and 74.0 per cent of the schools, and for seven periods per week in, respectively, 45.3 and 21.5 per cent. It is interesting to note that these four subjects were offered fewer than five times per week each in less than 1.0 per cent of the schools and that biology, physics, and chemistry were offered ten times per week in, respectively, 2.9, 4.2, and 3.1 per cent of the schools.

The modal number of different subject preparations per teacher per day was two. More than 25 per cent, however, of the teachers in schools enrolling between 0 and 251 pupils had five or more different preparations per day. In general the number of different preparations per day bore an inverse relation to the size of school.

NUMBER OF PERIODS DEVOTED TO LABORATORY WORK. The administrative plan most frequently reported for the four major branches of science provided two double laboratory periods per week; the percentages of teachers reporting this plan were 46.6 (biology), 58.8 (chemistry), 58.6 (physics), and 22.3 (general science). No definite periods were scheduled for laboratory work in 71.8 per cent of the programs of teachers of general science, in 38.8 per cent of those of teachers in biology, in 22.1 per cent of those of the teachers of physics, and in 21.8 per cent of the programs of teachers of chemistry. This statement should doubtless be interpreted to mean that in these programs such laboratory work as was included was given whenever it best fitted with the development of the work.

PUPIL ENROLLMENTS IN VARIOUS BRANCHES OF SCIENCE. The number of pupils who were reported to be studying the four major branches of science were 37,622 boys and 44,283 girls (biology), 38,225 boys and 25,697 girls (chemistry), 43,245 boys and 47,494 girls (general science), and 36,644 boys and 14,130 girls (physics).*

SIZE OF SCIENCE CLASSES. The modal class in biology and in general science had an enrollment of between twenty-six and thirty pupils; in

* These totals were compiled from the class enrollments as reported on the questionnaire by the teachers, and are valuable chiefly for purposes of comparison, since they are not complete for the reason that not all of the teachers gave their class enrollments.

chemistry and physics an enrollment of between twenty-one and twenty-five pupils. More than one quarter (26.6 per cent) of these classes in general science and about one-sixth (16.8 per cent) of the biology classes had between thirty-one and forty pupils enrolled.

In general, as would be expected, the size of class tended to increase with the size of the school, not only in the major but also in the minor branches of science.

THE INDIVIDUAL OR THE DEMONSTRATION PLAN OF LABORATORY WORK. With biology and general science the modal number of teachers used a combination of individual pupil experimentation with teacher and pupil demonstration; with chemistry and physics a majority of the teachers used individual pupil experimentation exclusively. With biology, individual laboratory experimentation by pupils was used exclusively by almost as many teachers as used the combination plan of individual experimentation and demonstration. While individual pupil experimentation was used exclusively by relatively few (8.1 per cent) of the teachers of general science, 42.2 per cent used the individual plan more or less frequently, while 85.7 per cent of these teachers used some form or other of the demonstration plan. Some teachers of each of the branches of science gave courses without any laboratory work whatever; the smallest percentage was found among teachers of physics (1.1); the largest among teachers of general science (5.9). Exclusive teacher demonstration was used by a relatively small percentage of teachers, except those of general science.

EVEN-FRONT AND ROTATION PLANS OF LABORATORY WORK. The "even-front" plan was used by a large majority of the teachers of biology, chemistry, and general science; the rotation plan was used by a large majority of the teachers of physics.

PROPORTIONATE USE OF SINGLE TEXTBOOK AND SYLLABUS COURSE. Respectively 82.6, 89.7, 88.9, and 92.5 per cent of the teachers of biology, chemistry, general science, and physics followed either a single textbook or a syllabus based on a single textbook with supplementary references. It would seem from the data that there is more latitude with biology than with the other three subjects, since more than half of the teachers of that subject used a syllabus of some sort, and another 14.8 per cent used a syllabus based upon no particular textbook.

USE OF SUPPLEMENTARY PERIODICAL LITERATURE. Of the teachers of the four major branches—biology, chemistry, general science, and physics, respectively 84.6, 87.0, 71.5 and 87.4 make occasional but regular classroom use of periodicals such as *Popular Science, Current Science, The Science Classroom,* etc.

EXTRA-CURRICULAR DUTIES OF TEACHERS OF SCIENCE. Most of these teachers of science assumed responsibility for one extra-curricular activity; only 8.5 per cent of the men and 7.2 per cent of the women sponsored more than two such activities.

PROFESSIONAL READING OF TEACHERS OF SCIENCE. The occasional reading of professional literature was far more frequently reported than its regular reading. The educational publications most frequently listed both for regular and for occasional reading were *School Science and Mathematics, Science Education, Journal of Chemical Education*, and *The School Review*. Of the scientific journals, those most frequently listed were *Science News Letter, Popular Science Monthly, Scientific American, Science, Science and Invention, Chemistry Leaflet, Scientific Monthly*, and *The Science Classroom*.

NOTICE

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An Elementary Science Game: Insects

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The game instinct and desire for achievement in contest is often used as a motivation device. This has a legitimate place in elementary science if not used so frequently that it loses its lure. The game described here may follow a study of four insects: the fly, the mosquito, the honey bee, and the ant; but the same idea may readily be adapted to a larger number or to a different group of insects.

Preparation of the Game

Materials needed. The materials needed are: 4 sheets of gray cardboard, 28″ x 22″; 6 pieces of white cardboard, 9″ x 10″; 22 pieces of white cardboard, 7″ x 8″; 26 pieces of white cardboard, 9″ x 3″; 28 small blocks of wood, approximately 1″ square; 28 small brass hooks and 8 large eyelets.

Place 7 screw hooks through each of the 4 large cardboards in the position indicated in the illustration and fasten them with blocks of wood on the back side. Punch-holes are made in the white cardboards, so they may be hung on the hooks.

Insect Cards. Find large pictures of the four insects or drawings to be copied, one on each 9 x 10 card. Small drawings in books can easily be enlarged by use of the reflectoscope. Place the cardboard at the right distance to give the desired size. In a similar way, diagrams can be reproduced by using glass slides or film strips in lanterns.

Association Cards. Paste pictures or make drawings of things related to the insect or which have associated ideas to them. These are to be put upon the white cardboard, 7 x 8 size. Make four association cards for each insect. Also, make six other cards of this size, by using drawings having no related ideas to any one of the four insects.

Factual Statement Cards. Print some statement about the insect or its habits upon the 9 x 3 card. Make four of these about each insect and six statements about insects which are not true for any one of these four. Print the names of the four insects in large letters, one on each of the 8 x 4 cards.

The sets of materials will now contain the cards shown in the accompanying figure as they appear at the end of the game:

I. *The Fly Set*

One card having the word *FLY;* one large card with drawing of fly; four association cards with drawings showing:

1. Life cycle of fly.
2. Graph of fly-time in summer.
3. Garbage breeding place.
4. Leg of fly.

Four small cards bearing these legends:

1. I breed in filth.
2. I carry thousands of tiny plants (bacteria) on my feet to your food.
3. I delight to feed on spoiled meat.
4. I cannot live and raise a family of children in a clean home and a clean neighborhood.

II. *The Mosquito Set*

One card having the word *MOSQUITO;* one large drawing of mosquito; four association cards with drawings showing:

1. Raft of mosquito eggs.
2. Wigglers.
3. Spraying oil on stagnant swamp water.
4. Tin can rubbish heap.

Four small cards bearing these legends:

1. I would like to drink some of your blood.
2. I pay for my food with saliva and germs.
3. Some of my sisters or cousins or aunts can make you sick with chills and fever.
4. My song may annoy, but it is not as bad as my bite.

III. *The Honey Bee Set*

One card having the word *HONEY BEE;* one large drawing of the honey bee; four association cards with drawings showing:

1. Leg of honey bee.
2. A queen cell.
3. A bee hive.
4. Eggs, larva, and pupa.

Four small cards bearing these legends:

1. People think of me as a busy-body, but I am idle all the winter.
2. My sharp needle is not used in sewing nor in drawing blood.
3. I help many plants to produce fruit and seeds.
4. I live in a man-made house, but I pay rent in the food I produce.

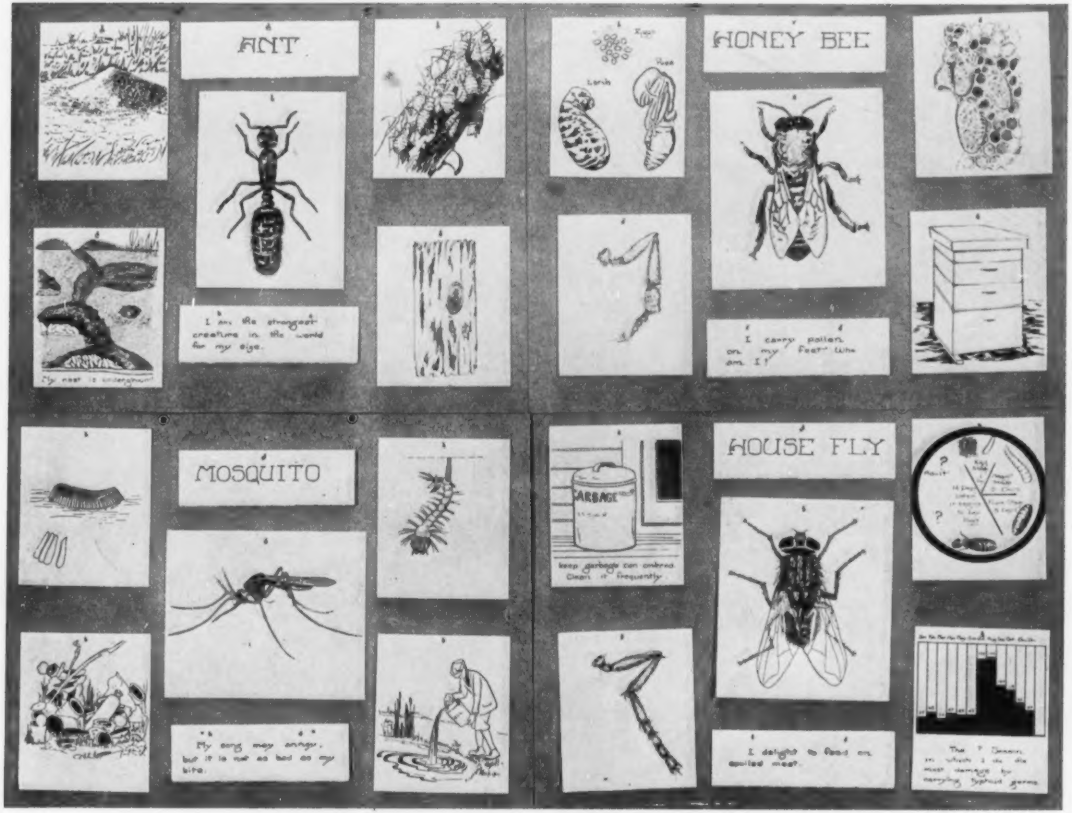
IV. *The Ant Set*

One card having the word *ANT;* one large drawing of the ant; four association cards with drawings showing:

1. Eggs in an ant nest.
2. An ant-hill.
3. Ant, eaten wood.
4. A group of aphids.

Four small cards bearing these statements:

1. I am the strongest creature in the world for my size.
2. I can repeatedly follow the same trail where people see no landmarks.


ANT
I am the strongest creature in the world for my size.
HONEY BEE
Eggs
Larva
Pupa
I carry pollen on my feet. Who am I?
MOSQUITO
My song may annoy, but it is not as bad as my bite.
Keep garbage can covered. Clean it frequently.
HOUSE FLY
I delight to feed on spoiled meat.

3. I sometimes become a pantry nuisance.
4. I build my house out of sand.

V. *Discards*

Two drawings of other insects (1) the grasshopper, (2) the cricket; five drawings showing:

1. Nest of tent caterpillar.
2. Hornet's nest on bush.
3. Cocoon.
4. A can of maple syrup.
5. Honey-dew melon.

Six small cards bearing these legends:

1. I am black, have a high-pitched voice, and spend much time under stones and boards.
2. My long legs make me a champion jumper.
3. I like to lay my eggs in a woolen suit.
4. I like to lay eggs on the under-side of a potato leaf.
5. I like best a home under the feathers next to the warm body of a hen.
6. My favorite food is corn and cornstalks.

How to Play the Game

Hang the four large charts in front of the room. Place the four cards with names of insects—fly, mosquito, honey bee, and ant—on the top center hooks. Put the drawings of these with the drawings of the grasshopper and cricket in one pile but have them second and fourth in the pile so that they will come up before the four large cards are filled. The sixteen association-idea and the six non-association-idea cards are thoroughly mixed and placed in a second pile.

The class is divided into two teams, A and B, each with a captain. Points for correct work and deductions for failures must be agreed upon as a basis for scoring. Errors may be left for someone coming later to correct or may be corrected at once, the first chance being given to the same side, or by the teacher, as agreed upon in planning details of scoring, but in any case the teacher is the final judge or referee. The game is begun by the captains. One takes a large card (drawing of insect) and places it on one of the four central hooks, under the card bearing the name of the insect, then the other captain places a second drawing in the proper place. If the insect on the card is not named on the chart, it is discarded.

The captains take places on opposite sides of the room and remain standing. In turn, each captain calls upon someone on his side who is seated to place a card upon one of the charts or to discard it. After his turn, each pupil stands in line on his side of the room. Each pupil named to go forward for his side, takes the top card and, if it is a drawing, tells the class what it represents and then hangs it upon the chart. If it is a state-

ment, he reads it to the class before putting it upon the chart. The score is kept on the blackboard.

The game may be varied by having the two teams standing at the start and letting each one, who fails, sit down. The team that has the larger number standing at the end of the game wins. If used in this way, unless the class is very small, it will be advantageous to increase the number of association cards and statement cards.

Some teachers may prefer to explain the general plan of the game before class study of the insects and have the pupils help in making the game. They can decide the factual statements they would like to use and the association pictures to make. A larger number of factual cards and association cards should be used if the class prepares them.

Education Value

As far as the writers know no investigation has been made to determine what educational value, if any, a game of this sort has in elementary science. If anyone who reads this article becomes interested in it, and has an opportunity and willingness to make a comparison of two groups, one using the game and another not using it, he is invited to report the results of the test to this journal. We should like to know whether your experience indicates any difference in the two groups: (1) in general interest, (2) in thinking ability, and (3) in information obtained.

The grades in which this material is used may vary widely, depending upon how much time is devoted to elementary science in the school. It is suggested that it be tried in some grade from three to six after the four insects, for which the sets of cards have been prepared, have been studied in class. Follow the game with another discussion period, and then a test. The game has been tried even in higher grades, and has never failed to stimulate intense interest and keen rivalry.

Meetings of N.A.R.S.T. and N.C.S.E.S.

The complete programs of the annual meetings of the National Association for Research in Science Teaching and the National Council of Supervisors of Elementary Science, to be held in Minneapolis at the time of the meeting of the Department of Superintendence of the National Education Association, will be found on pages 83 to 85.

Sound Motion Pictures as an Aid in Teaching Science

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In teaching a course in science to a group of students it is important that as much use as possible be made of demonstrations and experiments, and that all suitable visual aids be brought into the classroom. The fundamental principles of science and their applications are by nature abstract. Their comprehension is aided by demonstrations with the proper visual aids.

When the technique of the sound motion picture was developed, it was realized that educational sound films offered a possibility of bringing into the classroom many scientific illustrations which otherwise would be difficult and expensive to demonstrate. The problem of using silent motion pictures as an aid in classroom instruction in science has, for many years, been the subject of study both in this country and abroad. The value of educational silent films has been definitely established by a number of thorough and comprehensive experiments, an example of which was the series of investigations made by Wood and Freeman.[1] The results of these experiments show that the silent motion picture has a place as an aid in teaching. As a result, there is at present a wide use of such pictures in the elementary and secondary schools of the nation.[2]

The Problem

With the development of sound-motion pictures there has arisen the problem of the use and value of educational sound-motion pictures in classroom teaching. At present little is known of the exact value and place of such pictures as a teaching aid. There is need of extensive research to determine the effectiveness of the educational sound film as an aid in classroom instruction.

The first problem connected with the use of sound pictures in the classroom was the development of suitable pictures and reproducing equipment. A number of producing companies and educators are now working in this field.[3] The association of sound with motion pictures presents an entirely new educational problem. Before the exact place and value of the use of sound pictures as a part of an educational program can be established, it is necessary to determine the contribution, if any, made by the addition of sound to the film. This does not necessarily involve a complete evaluation

of motion pictures as teaching aids, but it merely involves the extension of the information already available on the use of silent motion pictures to the problem of the effectiveness of the association of sound with motion pictures. It is the particular effectiveness of this association of sound with the motion picture which is primarily the concern of this study.

The specific purpose of this investigation was to establish, as exactly as possible, the values of educational sound-motion pictures as a means for the conveying of concrete knowledge or information as compared with two other types of teaching aids; namely, silent motion pictures and lecture demonstrations. The investigation was concerned with the subject of science, and its application to the junior-college level of instruction.

The Experiment Described

The present experiment was carried out in the course, "Outlines of Science," a survey course in science, offered in the School of Commerce, Accounts, and Finance of New York University. It extended over a period of one academic school year. The students who were the subjects of this experiment were almost entirely freshman college students. In educational and intellectual development, the students constituted a highly homogeneous group. They were divided into two groups for experimental purposes: an experimental group and a control group. Each group consisted of approximately three hundred students. The sound films studied were used with the students in the experimental group and other means of demonstrating the same material shown in the films were used with the students in the control group. The groups were selected on the basis of the students' scores on the Army Alpha Examination and O'Connor Vocabulary Test, Work Sample No. 95, Form AA, in order to make them as nearly equal as possible in mental capacity.

The experiment consisted of two parts corresponding to two semesters of the school year. The films used in the first half of the experiment were related to the biological sciences.* Five sound films were used during this half of the experiment. These sound films were of the verbal lecture type. The sound consisted only of a spoken explanation and discussion of the items in the film by a speaker who was not seen in the picture. That is, the sound was entirely a speaking voice accompanying the various scenes in the films. The films used in the second half of the experiment were re-

* The titles and producers of these films are: "Castles of Paper" (Ufa), "Why Eyes Tell Lies" (Ufa), "Killing the Killer" (Talking Pictures Epic), "The Great Apes" (New York Zoölogical Gardens), "Monkeys" (Talking Pictures Epic), "Life in the Sea" (Ufa), and "Beavers" (Talking Pictures Epic).

lated to the physical sciences.† Three sound films were experimentally used in this part of the study. In these films the sound was a vital and integral part of the scenes in the picture. When an explanation was made, the speaker was shown in the picture and was working with the object talked about. All sounds which were natural to the objects in the picture were reproduced by the films. The sound in this case has the effect of being a part of the activities of the picture, rather than about these activities.

Three types of comparisons of the educational merits of sound films with the other two kinds of teaching aids used were made: (1) One consisted of using educational sound films with the experimental group and identical silent films with the control group; (2) A second consisted of using sound films with all the students to illustrate certain divisions of the subject matter, and using silent films with all the students to illustrate certain other closely related divisions of the subject matter. These two comparisons were made with the films relating to the biological sciences where identical sound and silent motion pictures and closely related sound and silent films are available. The sound films used in these comparisons were the lecture type of sound films; (3) The third type of comparison was made by using sound motion pictures with the experimental group and identical lecture demonstrations with the control group. This comparison was made with the films relating to the physical sciences. It was impossible to compare these sound films with silent films directly, as no silent films identical with these sound films are available. The sound pictures used in this comparison had the sound as a vital and integral part of the film.

In order to get a secondary cross comparison of sound and silent films relating to the physical sciences, certain silent films on additional divisions of the subject matter of the course were shown to the experimental groups, and lecture demonstrations of the items in the silent pictures were shown to the control groups.

This provided a comparison of the effectiveness of sound films as a teaching aid with silent films; also, a comparison of the effectiveness of sound films with lecture demonstrations. In addition, an indirect comparison between the effectiveness of sound and silent films was possible through the common element of the lecture demonstrations. When demonstrations were shown to the control groups in place of the films, these demonstrations

† The titles and producers of these films are: "Characteristics of Sound" (E.R.P.I.), "Liquid Air" (General Electric Co.), "Radio-active Substances" (General Electric Co.), "Wizardy of Wireless" (General Electric Co.), "Revelations by X-Rays" (General Electric Co.), and "Electromagnetism" (Carpenter Goldman).

TABLE I

COMPARISON OF SOUND FILMS WITH OTHER VISUAL AIDS

	Experimental Groups	Control Groups	All Groups
Sound Films	X		
Identical Silent Films		X	
Sound Films			X
Different Silent Films on Related Subject Matter			X
Sound Films	X		
Identical Demonstrations		X	
Silent Films	X		
Identical Demonstrations		X	

were in all cases identical with the objects shown in the films. Table I shows the nature of these three types of comparative studies.

The Tests Used

A battery of written tests was used to measure the relative effectiveness of the sound films in developing accurate, concrete knowledges or information as compared to silent films and lecture demonstrations as teaching aids. These tests were a comprehensive examination consisting of 99 different items relating to the factual content of the films. The examination which was constructed by the writer, as no satisfactory standardized tests of these subject-matter areas were available, was divided, for purposes of administering it, into two tests. Test I consisted of 61 items of the recall type. It was related to the films on the biological sciences, and was given only once, after the films had been used. The students' scores on this test were used for evaluating the relative effectiveness of these particular films. This test was, of necessity, divided into three parts. The first part, labeled Test I_L, covered the films of which the sound editions were used with the experimental group, and the silent films of identical content were used with the control group; the second part, Test I , was on the two sound films shown to both experimental and control groups; and the third part, Test I_N, was on the two similar silent films shown to both groups.

The second test, Test 2, was entirely of the multiple-choice type. It was made up of 38 items. It was related to the films on the physical sciences

and was given twice, before and after the films had been used. The gains in mean scores were used in evaluating the relative effectiveness of the films. Due to the conditions of the experiment, Test 2 was divided into six parts in administering it. The reliability of the different parts of the comprehensive examination was determined by calculating the half-test coefficients

TABLE II

SHOWING THE MEAN SCORES, MEAN GAINS, MEAN DIFFERENCES AND EXPERIMENTAL CONSTANTS OF THE EXPERIMENTAL GROUPS "A" HAVING THE SOUND FILMS AND THE CONTROL GROUPS "B" HAVING THE SILENT FILMS OR DEMONSTRATIONS. MINUS SIGN INDICATES ADVANTAGE IN FAVOR OF SILENT FILMS OR DEMONSTRATIONS

Test	Means "A"	Means "B"	Mean Difference Ma–Mb	Experimental Constant Ma–Mb ÷ P.E. Ma–Mb
1_L	13.39	13.88	−.49	−3.5
1_M	10.94		−1.78	−16.2
1_N		12.72		
	Gains Means "A"	Gains Means "B"		
2_R	2.06	1.99	+.07	+1.
2_A	2.72	2.75	−.03	−.4
2_S	2.64	2.59	+.05	+.7
2_W*	1.85	1.75	.1	+1.4
2_M*	3.85	4.35	−.52	−5.3
2_X*	2.17	2.20	.03	−.4

* For Tests 2_W, 2_M, and 2_X the experimental group had silent films and the control group had identical demonstrations.

of correlation. From these coefficients the reliability coefficients were determined by using the Spearman-Brown formula.[4] The reliability coefficients of the different parts of the comprehensive examination ranged from .83 to .91.

Results and Conclusions

In drawing conclusions from any investigation it is necessary to keep in mind the accuracy with which all factors of the experiment are controlled or evaluated, as well as the results which are obtained. To a large extent in this experiment all factors affecting learning, except the variable factor studied, were similar in the experimental and the control groups. Also, the standards used for comparison with the sound films differed from

the sound films chiefly in one respect; namely, the association of sound with moving pictures in the films. Therefore, to this extent, the purpose of this investigation was fulfilled; this being an experiment, first, to determine the relative educational advantages of the association of sound with the moving pictures as compared to silent moving pictures, and second, to compare the educational value of sound moving pictures with that of identical lecture demonstrations. The similarity of all conditions of the experimental and control groups except the one variable factor which it was proposed to study is believed to add to the significance of the results obtained.

The tests showed the results as given below and are believed to warrant the following conclusions regarding the educational values of sound motion pictures for regular classroom use as an aid in instructing mature students: (1) Educational sound films of the lecture type, in which the sound consisted only of a speaking voice accompanying the scenes of the pictures, were compared with silent films identical or very similar in content. The students having the silent films made higher scores than did the students having the sound films. The difference in scores in favor of the silent films was 3.5 times its probable error on Test I_L and the difference in favor of the silent films was 16 times its probable error on Test I_M and Test I_N. The scores are given in Table II, page 21. These are significant differences, and indicate clearly the superiority of the printed caption over this lecture type of sound film. The use of a spoken lecture, therefore, in place of the printed captions, in an educational moving picture is most likely to detract from its value in conveying specific information. In this connection, if such a sound film is produced for classroom use, it is necessary that a detailed knowledge of all learning factors involved in the situation be had and used. Also, the speaker's voice, his enunciation, the rapidity of his speaking and the exact explanations and interpretations given need to be carefully determined for each film.

(2) Educational sound films of the type in which the sound is a vital and realistic part of the pictures, were compared with lecture demonstrations identical with the items in the films. The differences in scores of the experimental groups having the sound films, and the control groups having the demonstrations, had experimental constants of 1. and .7 in favor of the sound films, and .4 in favor of the demonstrations on three divisions of the tests, as shown in Table II. These are not significant differences, and show that such sound pictures are equally as effective as the lecturer performing and explaining the actual demonstrations. Such sound films are, therefore, highly valuable for classroom use. The three silent films which were compared with identical lecture demonstrations, also showed results which were similar. The experimental constants were in the three

instances 5.3 and .3 in favor of the demonstrations, and 1.4 in favor of the films. These factors seem to indicate an advantage in favor of the demonstrations used over the silent films used. While these differences are small, the carefully controlled conditions of the experiment add to their significance. This type of sound film, when indirectly compared with silent films through the common medium of the lecture demonstrations, seems to be more effective and to afford more educational possibilities than the silent film. Many well-executed scientific experiments involving apparatus too delicate or too expensive for student handling, or experiments of microscopic views difficult of being seen by many at the same time, or animal and plant life and behavior which are foreign to the classroom may be vividly and effectively presented through such a sound film. The results show, however, that the sound film is to be considered as an aid in teaching and in no sense as a substitute for the personality of the instructor. In fact, to use sound films most effectively requires a higher degree of teaching skill than is needed for some other types of teaching aids.

References Cited

[1] Wood, Ben D. and Freeman, Frank N. *Motion Pictures in the Classroom.* Houghton Mifflin Co., New York, 1929.

[2] *Motion Pictures in the Public Elementary and Secondary Schools,* Office of Education, Washington, D.C.; Circular No. 46, January, 1932.

[3] *A New Force in Modern Education.* Pamphlet of the Educational Department of the Electrical Research Products, Inc., New York, 1-K-30-10.

[4] Holzinger, Karl J. *Statistical Methods for Students in Education.* Ginn and Company, New York, 1928. p. 168.

Present Objectives in Biology*

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The purpose of this study was first, to discover all the specific objectives in approved courses of study, textbooks, and curriculum investigations, and second, to assign to each a measure of its frequency of occurrence in these sources.† No attempt was made to organize them by grades or to validate them because we have no evidence to convince us that the *status quo* is an adequate basis for future courses in biology. However, I feel that this composite list of objectives, after the least important are eliminated, will yield a more dependable course of study than any now in use.

Procedure

Selecting a Tentative List of Sources. The first task was to select the sources of our objectives. A tentative list of curriculum investigations, courses of study, and textbooks was made. The curriculum investigations were limited to sound quantitative studies bearing upon the interests or needs of pupils between the ages of 11 and 16. The courses of study were those recommended by the Teachers' College Bureau of Curriculum Research supplemented by others which, the investigator was convinced, should also be included. The textbooks included practically all that were published in the last 10 years.

Submitting the Tentative List of Sources to Leaders in Science. This tentative list of sources was submitted to nine leaders‡ in the field of natural science with the request that they indicate: (1) which of the sources should be included in our study; (2) which should be excluded, and (3) which sources should be added. This resulted in the final selection of 16 publications: five curriculum studies, five courses of study, and six textbooks. The complete list of sources precedes the table of objectives given below.

Assembling the Objectives. Before proceeding to make the inventory, we agreed on an interpretation of the term "objective." To us the term means a specific goal expressed in the terms of useful life situations. In determining how specific an objective should be, we agreed that it should

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* Paper read at the Atlantic City meeting of the N.A.R.S.T., February, 1930.

† The technique follows that used by Henry Harap and Ellis C. Persing for "The Present Objectives in General Science."

‡ Otis Caldwell, C. W. Finley, S. R. Powers, E. Lawrence Palmer, Francis D. Curtis, Morris Meister, N. R. Van Cleeve, W. L. Eikenberry, and W. R. Teeters.

be concerned with a fairly small unit of life activity, that it should suggest a rather definite classroom activity, that it may be accomplished in a fairly short period of time, and that the achievement of it may be readily observed or measured. Since some of our sources failed to state objectives, we were obliged to infer the author's implied goals from a reading of the context. When the source consisted of a bare list of topics we asked ourselves, "What is the child's objective suggested by the term?" Each objective was placed on a filing card, together with a key number indicating its source. This procedure yielded 732 objectives.

Sorting the Objectives under Main Headings. Obviously, it was impossible to treat the objectives in bulk. It, therefore, was necessary at this point to determine first, the main headings, and second, the main divisions of biology, the latter being more general. Units of actual life activity were especially sought. For this purpose two principal sources were used, namely, the section or chapter headings of twelve textbooks of biology and the science headings listed in Bobbitt's extensive study of the major activities of life.* The topics from the study by Bobbitt yielded some items which were not found in textbooks. Furthermore, after sorting the objectives, I found a residue for which I had to assign additional headings. The main divisions were determined by combining several related main headings into more inclusive natural fields of life. The list of main headings included: activities of living things; improving animals; improving plants; inter-relationship of plants and animals; classification; environment; reproduction; control of injurious animals; animals and disease; civic hygiene; sanitation; recreation; control of injurious plants; economic importance of plants and animals; conserving animals; conserving plants; keeping well; safety first; control of body; and food and nutrition.

The cards were first sorted under the main divisions, such as, "how plants and animals live" and "community." Then they were sorted under main headings, such as, "activities of animals and plants" and "improving animals." Similar objectives were combined and counted. The frequency of occurrence was recorded and transferred to the table which is produced and discussed below.

There is some duplication of objectives which will be obvious to any reader of this report, but I could not escape it because I was obliged to report the treatment given by the authors in their works. For example, objective number 59, "To know how single-celled animals live," has a slightly different emphasis from number 58, "To know how protozoa live and are controlled."

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* Bobbitt, F. *Curriculum Investigations,* Chapters 1-6, University of Chicago Press, 1926.

TABLE I

FREQUENCY OF OBJECTIVES UNDER EACH MAIN HEADING AS FOUND IN 5 INVESTIGATIONS, 5 COURSES OF STUDY, AND 6 TEXTBOOKS

Heading	*Investigations*	*Courses of Study*	*Texts*	*Total*
How Plants and Animals Live	94	145	201	440
Activities of living things	42	122	144	308
Improving animals	3		4	7
Improving plants	6	5	4	15
(Interrelationship of plants and animals)	2	3	1	6
Environment	4	3	13	20
Classification	4	4	9	17
Reproduction in living things	33	8	26	67
Community	8	5	16	29
Control of injurious animals	2	2	6	10
Control of injurious plants	2		3	5
Civic hygiene	1	3	2	6
Animals and disease	1		3	4
Recreation	1			1
Sanitation	1		2	3
Conservation	24	32	36	92
Economic importance of plants and animals	19	31	29	79
Conserving animals	2		1	3
Conserving plants	3	1	6	10
Famous biologists	2	4	4	10
History of biology		1	1	2
Biographies	2	3	3	8
Theories	4	3	1	8
Popular theories	4	3	1	8
Man	48	43	62	153
Keeping well	25	26	33	84
Safety first	1			1
Control of body	2	5	7	14
Foods and nutrition	20	12	22	54
Totals	180	232	320	732

The Table of Main Headings

Table I gives the frequency of objectives by main headings and main divisions. At a glance certain conclusions are obvious. Activities of living things, man, conservation, and community are the headings most frequently represented. The main division most frequently represented is "how plants and animals live," followed by "keeping well" and "economic importance of plants and animals." The table shows that textbooks are most heavily represented in the total results, supplying about one-half the objectives. The data from curriculum investigations furnished about one-sixth the number of objectives.

*The Table of Present Objectives**

The main contribution of this study is a table of the objectives found in the most satisfactory existing curriculum investigations, courses of study, and textbooks. With these data is a list of the sources used, together with a key number for each source. The frequency of an objective in any given source is shown by a key number. Thus the reader knows both the commonness and exact source of each objective at a glance. Interesting comparisons can easily be made by referring to the frequency of occurrence in the four columns—investigation, courses of study, texts, and total. There are 376 objectives in the final table.

This table enables the curriculum maker or teacher to get a convenient picture of the present status of the content of biology. He can use the most common objectives as the basis for his reconstructed course. Again overemphasis or omissions can be discovered by comparing a given course with these data.

Conclusions from a Study of the Tables

The investigator found many objectives stated too vaguely and broadly to be most useful, for example: "to know about orchards," "to know about plants from other countries," "to know factors of environment," "to know mountain-top biology."

This list of sources represents the best investigations, courses of study, and textbooks in the opinion of nine leaders in the field of natural science. The curriculum-making group or teacher of biology will find the references at the head of the table of objectives helpful.

Seventy-five objectives discovered in the curriculum investigations do not appear in courses of study and textbooks in the form stated as specific objective, although many of them are included in other objectives. For example, "to know the importance of chromosomes" is considered under the objectives "to know the function of cells." Then too, some of the objectives, such as, "to know how to care for animals," "to know what vegetables are," "to know how to grow garden flowers," and "to protect the game birds," belong to elementary science or general science. This warrants the inference that there is room for revision in courses of study and textbooks in biology.

The textbooks appear to attach more importance to certain topics, such as, "reproduction in animals," "conservation of the forests," and "insects and disease," than the investigations warrant.

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* The above is a restatement of the procedure followed by Harap and Persing in "Present Objectives in General Science," with necessary modifications to conform to the biology course.

From a comparison of the treatment of the main heading we are led to several conclusions. The textbooks and courses of study treat "activities of living things" more extensively than investigations seem to require, but that may be due to lack of investigations on the topics for high-school biology. Investigations place more emphasis on reproduction than do the courses of study and texts. Courses of study give more emphasis to "economic importance of plants and animals" than investigations or texts.

The place of certain topics, such as, "food and nutrition," "civic hygiene," and "environment," seem uncertain for biology since they are shown to be already a part of the general science courses.*

The investigator is convinced that the field of high-school biology as it is now constituted is in need of further evidence to justify it. The number of investigations, thus far carried on, is insufficient to establish definitely the content of high-school biology.

The investigator is convinced that an intensive study of grade placement for the twelve grades will help to avoid duplication of the objectives in the elementary school, junior-high school, and senior-high school. A large number of the objectives presented here for ninth or tenth grade are of elementary-school level. When texts do not treat "identification of common insects," "characteristics of mammals," although some courses of study require that they be taught, it is because the authors assume that they should be covered in the elementary science. When courses of study prescribe definite work on identification of common birds, do they recognize the study of science in the elementary and junior-high school? A certain amount of repetition is justified, but it should be definitely planned.

At present there are not enough curriculum investigations to establish biology objectively. They list only 180 of the total 732 objectives. Of this number only three objectives are listed by three investigators and only one by four investigators.

The investigator undertook to discover the present objectives of high-school biology from a carefully selected list. Specific objectives were assembled and recorded in a table, showing the most common objectives found in curriculum investigations, courses of study, and textbooks. A study of the table has yielded several conclusions, one of which is that there is a great need of further original investigation to establish the objectives of high-school biology.

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*Harap and Persing. "Present Objectives in General Science."

SOURCES OF PRESENT OBJECTIVES (SPECIFIC) IN HIGH-SCHOOL BIOLOGY

Key Number

Curriculum Investigations

1 FINLEY, C. W. and CALDWELL, O. W. *Biology in the Public Press.* Lincoln School, Teachers College, Columbia University, 1923.

2 HIMES, H. E. "What Biology Functions Most Largely in Giving Pleasures of Recognition." *Second Yearbook of the National Society for the Study of Educational Sociology,* pp. 118-126.

3 HUNTER, G. W. "The Report of the Committee on a One-Year Fundamental Course of Biological Science." *School Science and Mathematics,* October, 1923.

4 PERSING, ELLIS C. Chairman "Cleveland School Masters' Club, Committee Reports on General Science, Physics, Chemistry, and Biology." *School Science and Mathematics,* June, 1925.

5 RUCH, G. M. and COSSMAN, L. H. "Standardized Content in High School Biology." *Journal of Educational Psychology,* May, 1924.

Courses of Study

6 Denver, Colorado. General Science for Grades 7 and 8, Biology Grade Nine, 1924.

7 Los Angeles, California. Course of Study Monographs No. 130, Biology, 1923.

8 St. Louis, Missouri. Biology Curriculum Bulletin No. 30, 1926.

9 State of New York. Syllabus for Secondary Schools Biology, 1924.

10 State of New Jersey. Course of Study in Biology, 1927.

Text Books

11 ATWOOD, WILLIAM H. *Biology.* P. Blakiston's Son and Co., 1927.

12 GRUENBERG, BENJAMIN C. *Biology and Human Life.* Ginn and Co., 1925.

13 HUNTER, GEORGE W. *New Civic Biology.* American Book Co., 1926.

14 KINSEY, ALFRED. *Introduction to Biology.* J. B. Lippincott Co., 1926.

15 MOON, TRUMAN J. *Biology for Beginners.* Henry Holt and Co., 1926.

16 PEABODY, J. E. and HUNT, A. E. *Biology and Human Welfare.* The Macmillan Co., 1924.

THE PRESENT OBJECTIVES IN BIOLOGY

I. HOW PLANTS AND ANIMALS LIVE

1. *Activities of Living Things*

1. To know the function of stems—6, 10, 11, 15, 16.
2. To know the structure of stems—5, 6, 8, 9, 10, 11, 15, 16.
3. To know how stems grow—11.
4. To know the kinds of underground stems—11.
5. To know the kinds of leaves—11.
6. To know why we study leaves—11.
7. To know the structure of leaves—6, 9, 11, 13, 14, 15, 16.
8. To know the function of leaves—5, 6, 7, 8, 9, 10, 11, 13, 15, 16.
9. To know how seeds germinate—8, 9, 10, 11, 15.
10. To know conditions necessary for growth of seeds—3, 4, 16.
11. To know the structure of a seed—6, 8, 9, 10, 12, 13, 15.
12. To know the function of seeds—12, 13, 15.
13. To know the structure of a bean—15.
14. To know the structure of a grain of corn—13.
15. To know the characteristics of arthropods—15.
16. To know the characteristics of roots—15.
17. To know the kinds of roots—11.
18. To know the structure of roots—6, 9, 10, 11, 14, 15, 16.
19. To know roots are dependent on soil—11.
20. To know the function of roots—3, 5, 6, 8, 9, 10, 11, 13, 15, 16.
21. To know the importance of chromosomes—3.
22. To know the function of cells—3, 4, 5, 9, 10, 11, 12, 13, 14, 15.
23. To know the structure of cells—5, 11, 13, 15.
24. To know how plants and animals react to stimuli—3, 7, 10, 11, 12, 13, 14, 15.
25. To know intelligent behaviors—12, 15, 16.
26. To know the life process of living things—3, 5, 6, 9, 13, 14, 15.
27. To know the characteristics of insects—5.
28. To know some common insects—6, 8.
29. To know the structure of insects—5, 8.

30. To know fresh water biology—14, 15.
31. To know the characteristics of bacteria—4, 9, 15.
32. To know how bacteria live—11, 13, 16.
33. To know how bacteria are distributed—3.
34. To know the useful forms of bacteria—6.
35. To know characteristics of birds—10.
36. To know life processes of birds—9.
37. To recognize some common birds—6, 8.
38. To know how birds live—2.
39. To know bird behavior—14.
40. To know structure and adaptation of birds—4, 8, 15.
41. To know bird habits—15.
42. To know how fish reproduce—9.
43. To know structure and adaptation of fishes—8, 9, 15.
44. To know life process of fishes—2, 6, 9, 10.
45. To know how food is stored in plants—3, 10, 11.
46. To know the use of vitamines—11.
47. To know the kinds of food—11.
48. To know the meaning of food—12.
49. To know the sources of food—12.
50. To know how food is absorbed and distributed in plants—3, 12, 13.
51. To know digestion in plants and animals—7, 9, 13, 15.
52. To know what enzymes do—11.
53. To understand photosynthesis—3, 4, 9, 12.
54. To know structure of paramoecium—6.
55. To know structure of amoeba—6.
56. To know characteristics of protozoans—8, 9, 10, 13.
57. To know how protozoa live—6.
58. To know how protozoa live and are controlled—11.
59. To know how single-celled animals live—16.
60. To know how the amoeba lives—2, 13.
61. To know the process of respiration in plants—3, 10.
62. To understand the process of respiration—12.
63. To know how living organisms breathe—16.
64. To know the process of respiration in animals—3.
65. To know respiration and excretion—14.
66. To understand respiration in plants and animals—7.
67. To understand transpiration—3, 7.
68. To know the function of fruits—6, 11.
69. To know structure and function of fruits—6, 15.
70. To know characteristics of spore plants—4, 15.
71. To know kinds of fruits—9, 11.
72. To know what a fruit is—4.
73. To know process of osmosis—4, 11, 13, 15.
74. To know characteristics of living things—6, 7, 10.
75. To know elements found in living things—15.
76. To know what plants are—4.
77. To know what animals are—4.
78. To know wastes are elminated from living things—12.
79. To understand the process of excretion—7.
80. To understand excretion in plants—3, 10.
81. To know facts about the yeast plants—4.
82. To know structure and use of yeasts—15.
83. To know how yeast plants live—11.
84. To know characteristics in mammals—6, 9, 10.
85. To know how mammals live—6, 15.
86. To know some common fungi—8.
87. To know characteristics of fungi—10.
88. To know how fungi get their food—14.
89. To know energy is developed in living things—16.
90. To know the composition of living things—3, 12.
91. To know the common elements and compounds—9.
92. To know the composition of matter—7.
93. To know the nature of matter—15.
94. To know chemical and physical changes—15.
95. To know some common compounds—15.
96. To know what minerals are found in plants—11.
97. To know nitrogen cycle—6, 13.
98. To know carbon cycle—6.
99. To know the food cycle in an aquarium—11.
100. To know the food cycle—11.
101. To know the nervous system of animals—8.
102. To know structures in animals—14.
103. To know the characteristics of the animal groups—14.
104. To know curious things about animals—1.
105. To know the embryonic development of animals—14.
106. To know the function of gills in animals—4.
107. To know the characteristics of insects—10, 13.
108. To know how reptiles live—4, 15.
109. To know the functions of the flowers—3, 8, 9.
110. To know common garden flowers—6.

111. To know the structure and function of a flower—9, 13, 15, 16.
112. To know the structure of a flower—6, 13.
113. To know the pollination and fertilization—15.
114. To know the function of a bird—14.
115. To know how to grow garden flowers—1.
116. To know method of cultivating plants—1.
117. To know how to plant a garden—6.
118. To know about orchards—1.
119. To know characteristics of ant colony—6.
120. To know how social wasps and bees live—14.
121. To know how bees live—15.
122. To know how the honey bee lives—9.
123. To know the structure of a grasshopper—9.
124. To know life processes in grasshoppers—9.
125. To know how the grasshopper lives—2.
126. To know some adaptations of animals for getting their food—11.
127. To know adaptations of roots—15.
128. To know adaptations of hydra—6.
129. To know adaptations of fishes—6.
130. To know adaptations of birds—6.
131. To know adaptations of mammals—6.
132. To understand adaptations—9, 11.
133. To know some adaptations—3, 5.
134. To know interrelation of living things—3.
135. To know how flowering plants are adapted to seed production—11.
136. To know adaptations of flowers—6.
137. To understand protective resemblance of insects—9.
138. To know adaptations of insects—6.
139. To know characteristics of crayfish—10.
140. To know structures and adaptations of the crayfish—15.
141. To know the important structures of the crayfish—6, 9.
142. To know how the crayfish lives—16.
143. To know adaptations of worms—15.
144. To know structure of worms—15.
145. To know characteristics of earth worm—10.
146. To know how frogs live—2, 3, 16.
147. To know how frogs and their relatives live—15.
148. To know life processes in frogs—9.
149. To know adaptations of frogs—6, 9.
150. To know characteristics of amphibians—10.
151. To know important structures of frogs—9.
152. To know some common algae—6.
153. To know characteristics of algae—4, 10.
154. To know how maple sugar is obtained—4.
155. To know characteristics of gymnosperms—10.
156. To know the structure of vertebrates—8.
157. To know the meaning of metazoa—15.
158. To know how galls are formed—14.
159. To understand growth—4.
160. To know importance of plants and animals—13.
161. To know characteristics of angiosperms—10.
162. To know tissues—15.
163. To know organs—15.
164. To know how crustaceans live—6.
165. To know common mushrooms—6.
166. To know common trees—6.
167. To know common weeds—6.
168. To know the essential facts about sponges—4.
169. To know what vegetables are—4.
170. To know about new plants from other countries—1.
171. To know characteristics of fur-bearing animals—8.
172. To understand the division of labor—4, 13.
173. To know uses of soils to plants—8.
174. To know how to control molds—4, 6.
175. To know the nature of parasitism—14.
176. To know how ants and termites live—14.
177. To understand a balanced aquarium—11.
178. To understand assimilation—10.
179. To know essential facts about mollusks—6.
180. To know how fossils are formed—13.

2. *Improving Animals*

181. To know how new kinds of animals are obtained—14.
182. To know how to care for animals—1.
183. To know methods of animal breeding—12, 13.
184. To know how animals can be improved—1, 3, 11.
185. To know how to improve crops—1, 3, 8.
186. To know methods of plant breeding—4, 12, 13.
187. To know how to produce more beautiful flowers—1, 4, 14.
188. To know the nature of heredity—3, 7, 8, 14.

189. To know how to control weeds—6.
190. To know how to control wheat rust—6.

3. *Interrelationship of Plants and Animals*

191. To know the interrelations of animals—1.
192. To know the interdependence of plants and animals—5, 6, 10.
193. To know the interrelation of animals, man, and plants—9.
194. To know the relation of insects and flowers—14.

4. *Environment*

195. To know the life zones—6, 14.
196. To know the environment of plants and animals—11, 13.
197. To know the factors of environment—3, 9, 11, 16.
198. To know how soils are formed—11.
199. To know the kinds of soils—11.
200. To know mountain-top biology—14.
201. To know how the amount of rainfall affects plant growth—1.
202. To know how temperature affects plant growth—1.
203. To know how organisms are distributed—14.
204. To know ecological relations of organisms—14.
205. To know conditions necessary for life—7.
206. To know about the geographical distribution of animals—1.
207. To know the relative importance of heredity and environment—14.
208. To know the importance of soil—12.
209. To know how water moves through the soil—11.

5. *Classification*

210. To know the classification of animals—3, 5, 7, 10, 13, 14.
211. To know the classication of plants—3, 5, 7, 10, 11, 12, 13, 14.
212. To know edible and poisonous mushrooms—15.
213. To know taxonomists as explorers—14.

6. *Reproduction in Living Things*

214. To know reproduction in plants—4, 7, 14.
215. To know the life history of a moth—5, 6, 9, 14.
216. To know the importance of pollination—12, 13, 16.
217. To know the development of mammals—3.
218. To know the life history of algae—11.
219. To know the life story of the goldenrod—11.
220. To know the life history of the mosquito—5.
221. To know the life history of the fern—5, 11.
222. To know how seeds are distributed—3, 11, 13.
223. To know reproduction in animals—3, 5, 11, 12, 13, 14, 16.
224. To know the life history of a bee—5, 11.
225. To know the life history of a moss plant—5, 10, 11.
226. To know the life history of a grasshopper—2, 5, 11, 15.
227. To know the life history of insects—1, 4, 6, 10.
228. To understand fertilization—7.
229. To know how seeds are formed—3.
230. To understand sexual reproductions in plants and animals—7.
231. To know the uses of fruit in reproduction—3.
232. To know the life history of the fish—2, 5.
233. To know how one-celled plants and animals reproduce—3.
234. To know the life history of paramecium—15.
235. To know the life history of parasitic worms—5.
236. To know how birds reproduce—2.
237. To know the life history of the amoeba—2, 15.
238. To know the life history of molds—5.
239. To know the life history of the crayfish—5.
240. To know the life history of the fly—5.
241. To know the life history backet fungus—5.
242. To know the life history of a sponge—5.
243. To know the life history of malaria organisms—5.
244. To know the life history of yeast—5.
245. To know the life history of a frog—2, 3, 5, 15.
246. To know how plants reproduce—5, 10, 12, 13, 16.

II. Community

1. *Control of Injurious Animals*

247. To know how to control pests—14.
248. To know what animals carry diseases—13.
249. To know how flies are related to human diseases—4, 11.
250. To know how to control injurious insects—1, 9, 10, 11.
251. To know the life history of Trichnia, Hookworm tapeworm—15.
252. To know why the rat is an enemy of mankind—11.

2. *Control of Injurious Plants*

253. To know obnoxious plants—1.
254. To know how to control weeds—11.
255. To know how to control bacteria—1, 13, 15.

3. *Civic Hygiene*

256. To know some state and national health activities—9.
257. To know the industrial problem of health—12.
258. To know civic hygiene—5, 6, 9, 12.

4. *Animals and Disease*

259. To know insects in relation to disease—12, 13, 16.
260. To know some important diseases of animals—1.

5. *Recreational*

261. To know the recreational value of the forests—1.

6. *Sanitation*

262. To know how to dispose of sewage—13.
263. To know methods of municipal sanitation—3.
264. To know how to care for water supply—13.

III. Conservation

1. *Economic Importance of Plants and Animals*

265. To know the economic value of forests—1, 3, 5, 9, 12, 13, 14, 15.
266. To know the cause of disease in plants—11.
267. To know the importance of lichens—7, 10.
268. To know the economic importance of fishes—2, 6, 9, 10, 16.
269. To know the economic importance of bacteria—6.
270. To know how bacteria are beneficial—9. 11.
271. To know how bacteria are injurious—9, 11, 13, 16.
272. To know the relation of insects to human welfare—12.
273. To know the economic importance of the grasshopper—2.
274. To know the economic importance of insects—5, 8, 9, 10, 14, 16.
275. To know the economic value of plants—3, 5, 12, 15.
276. To know the economic value of fungi—9, 13.
277. To know plants and animals as sources of useful materials—12.
278. To know the economic value of plants as food for man—1.
279. To know plants that are injurious to man—16.
280. To know uses of plants for foods, beverages, and medicines—16.
281. To know the importance of green plants to man—13.
282. To know the economic importance of weeds—6.
283. To know the economic importance of algae—9.
284. To know the use of yeast in household—6.
285. To know the importance of ferns—10.
286. To know the economic importance of birds—2, 6, 9, 10, 12, 14, 15, 16.
287. To protect the game birds—1.
288. To know the economic importance of animals—1, 12, 13.
289. To know the relation of animals to wealth—3.
290. To know the economic importance of plants as food for animals—1.
291. To know the economic importance of earthworm—8.
292. To know the economic value of worms—6, 13.
293. To know the economic importance of mammals—9, 10, 15.
294. To protect game mammals—1.
295. To know the economic value of invertebrates—5, 15.
296. To know the economic value of protozoa—6, 9.
297. To know micro-organisms that are beneficial—7.
298. To know micro-organisms that are injurious—7.
299. To know the economic importance of frogs—2.
300. To know the economic importance of amphibians—10.
301. To know the economic importance of amoeba—2.
302. To know the economic importance of sponges—10.
303. To know the economic value of vertebrates—15.
304. To know the economic importance of the crayfish and its relatives—9.

2. *Conserving Animals*

305. To know the work of the government in conserving wild life—3.
306. To know how to protect birds—3, 15.

3. *Conserving Plants*

307. To know how to conserve the forests—1, 12, 13, 15.
308. To know how to prevent forest fires—1.
309. To understand the conservation of biological wealth—10, 11.
310. To know facts about conservation of natural resources—15.
311. To know how reforestation is done—1.
312. To know uses of forests—16.

IV. Man

1. *Keeping Well*

313. To know the relation of insects to disease—3, 9, 14.
314. To know the relation of protozoa to disease—3, 5.
315. To know the structure and use of the sense organs—3, 11.
316. To understand circulation in animals and the human—3, 5, 6, 7, 9, 10, 12, 13, 15, 16.

317. To know the effect of using tobacco and alcohol—11, 13, 15, 16.
318. To know the function of the skin—12, 13, 16.
319. To know hygiene of respiration—3, 5, 6, 9, 10, 11, 12, 13, 15.
320. To know the use of muscles—3, 9, 10, 15.
321. To know personal hygiene—1, 4, 5, 6, 10, 12.
322. To know the life history of worms that cause disease—10.
323. To know bacteria as foes of man—16.
324. To know the use of enzymes and glands—3.
325. To understand reproduction—10.
326. To know the essential facts about emotions—12.
327. To know meaning of habits—12.
328. To know the function of ductless glands—10.
329. To know facts about cancer—4.
330. To know about goiter—1.
331. To know correct posture—9.
332. To know the hygiene of the skeleton—7, 9, 16.
333. To know the causes and prevention of disease—1, 2, 3, 4, 5, 6, 9, 11, 12, 13, 14, 16.
334. To know hygiene of excretion—3, 6, 7, 9, 10, 15.
335. To know the dangers of patent medicines—16.
336. To know the hygiene of the foot—9.
337. To understand assimilation in human body—10.
338. To know biology and health—15.
339. To know how to keep children healthful—1.
340. To know the general structure of the body—15.
341. To know how the heart works—4.
342. To know how to care for eyes and ears—16.
343. To know the adaptations of the human body—5.

2. Control of Body

344. To understand the nervous system—4, 8, 15.
345. To know the structure and function of nervous system in man—9, 13.
346. To know the hygiene of the sense organs—13.
347. To understand reflexes—9, 12.
348. To know about the brain—4, 5, 12.
349. To know how our bodies are controlled—6, 10, 11, 16.

3. Foods and Nutrition

350. To know a properly balanced diet—13.
351. To know how to preserve food—1, 11.
352. To know essential facts about foods—1, 3, 15.
353. To know how to care for foods—1, 13.
354. To know how to reduce the price of foods—1, 3.
355. To know the composition of foods—5, 13, 16.
356. To know why we should eat—11, 16.
357. To know the structure and function of the digestive system—6, 13, 16, 10.
358. To know how to obtain pure foods—1. 3.
359. To know methods of conserving the food supply—1.
360. To know tests for food—5, 13.
361. To know the food needed by the human body—6, 12, 14, 16.
362. To know the hygiene of the digestive system—3, 4, 9, 12, 13, 14, 15, 16.
363. To know the kinds of food—10, 13, 14.
364. To know food requirements—3, 5, 7, 9.
365. To know pure food laws—3, 7, 9, 13.
366. To understand absorption—10
367. To know how foods are distributed—1.
368. To know the meaning of foods—4.
369. To know the uses of food—9.
370. To know assimilation—3.
371. To know use of drugs—1.
372. To know cost of food—13.

V. Miscellaneous

373. To know the history of biology—8, 14.
374. To know the biographies of some biologists—3, 5, 6, 9, 10, 11, 13, 15.
375. To understand evolution—1, 3, 4, 5, 6, 7, 10, 14.
376. To learn how to prevent accidents—1.

Methodology in Science at the Junior- and Senior-High-School Levels

George W. Hunter and Oscar H. Edinger, Jr.

The present decade has witnessed more interest in experimental teaching and greater activity in working over the real problems in science teaching at the junior- and secondary-school levels than has been witnessed at any previous period. The growth of the junior high school, with its frankly experimental attitude, has awakened some senior-high-school teachers to the fact that methods used in science at this age level may not be perfect and that the aims and objectives in science should be tested experimentally to see if they are giving the results they are supposed to give. Since we have eliminated faculty psychology from our thinking, we are forced into an experimental attitude, for each subject at the junior- and senior-high-school levels must show its values, and this through the use of objective data. It is not strange then, that problems have arisen with reference to method, some of which have had experimental testing and some of which are still unsolved. Such problems might be: (a) What methods in the teaching of science should receive the most emphasis at the different age levels in the junior and senior high schools? (b) Is the laboratory rightfully holding its own, or should the lecture-demonstration take its place? If so, where and when should this be done? (c) When should the developmental or discussion method be used in the classroom? (d) Under what conditions should the project be used and to what extent? (e) What is the place of the textbook? (f) How should field work be utilized? These and hundreds of other questions come to the minds of any thinking teacher of science.

In May and September, 1930, the senior writer sent out an elaborate questionnaire on the methods, content, and place of science in the junior- and senior-high school. These questionnaires were sent to about 1200 junior- and senior-high schools in every state in the Union. The schools were selected from a carefully prepared list obtained from government sources and from private information with reference to the schools. Answers were received from 517 schools, 206 being junior high schools, 117 being three-year high schools, and 197 being four-year high schools. Since the questionnaire was voluminous and demanded considerable time and work on the part of the teachers, it can be assumed that the teachers answering represent a cross section of the best type of secondary-school teachers in the country. In addition questionnaires were sent out to the members of

the National Association for Research in Science Teaching, of which the senior author is a member. Replies were received from 28 out of the 40 members. This second group represents leadership in supervision and practice teaching in the teacher groups and supervisors representing the larger school systems in the country. The opinions coming from such a group would be based upon the best practices and frequently upon experimental evidence. It is obvious, therefore, that the answers received represent the best practices and thought on methodology in science in this country.

One of the questions which the senior writer considered to be of most importance was that concerned with the relative emphasis placed on teaching methods at the different age levels in the junior and senior high school. This question was formulated in the manner shown below in order to save time for both the teachers answering and those tabulating the results.

For each subject given in your school indicate by the numerals 1, 2, 3, 4, 5, 6, 7, etc. the relative emphasis placed on different methods listed.

	Text Book	References and Reports	Individual Lab. Work	Demonstrations	Class Discussion	Field Work, Excursions	Projects	Other Methods
Advanced Biology								
Agriculture								
Astronomy								
Bacteriology								
Botany								
Chemistry								
Elementary Biology								
Elementary Science								
Hygiene								
Human Physiology								
Physics								
Physiography								
Zoology								
Other Sciences								

For the preparation of the graphic representation of the results the following method of weighting was used. This was an arbitrary method but a valid one for graphic representation, provided the reader does not take the percentages as literal. All first places in the summaries were multiplied by eight, second places by seven, third places by six, and so on down to the eighth place which was multiplied by one. In case the person answering gave equal weight to two or more methods, an average was taken. In a number of cases not all the methods were rated. In such cases only the methods rated were given consideration. A number of answers had to be

FIGURE 1—Elementary Science 7th-8th Grades

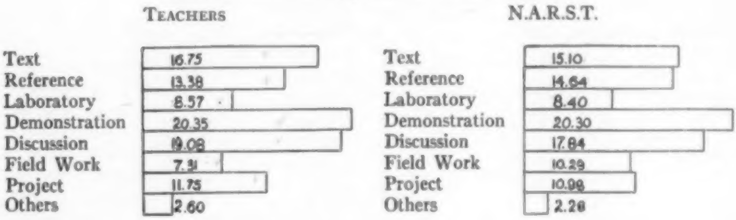
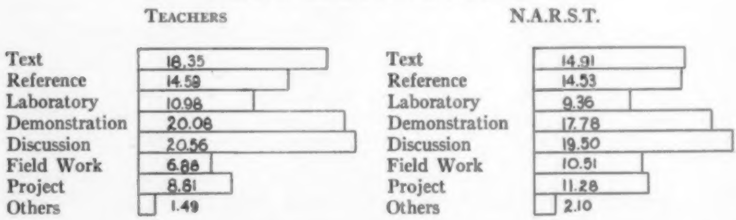


FIGURE 2—General Science 9th Grade



thrown out because of a lack of definiteness. The entire group of answers for each state was then summed up, addition made of all of the weighted points under each heading made, and the whole reduced to a proportional basis for the sake of preparing graphs. The results are seen in Figures 1 to 5. It must be understood that these graphs represent tendencies and not actual percentages of the emphasis placed on the different methods mentioned.

For the sake of comparison the answers from the teachers and from the members of the N.A.R.S.T. have been placed side by side. One of the most interesting features of this comparison is the rather definite correlation of methods which occur. Another interesting feature is that more definite correlation by the teachers and the N.A.R.S.T. seems to exist at

FIGURE 3—Elementary Biology 10th Grade

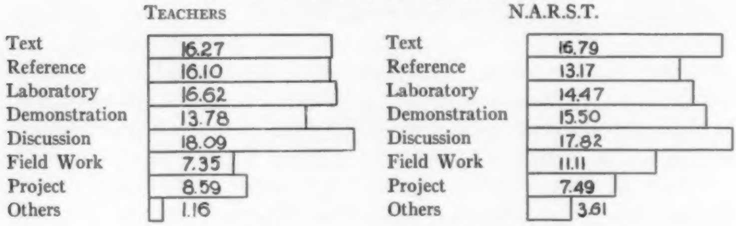


FIGURE 4—Chemistry 11th Grade

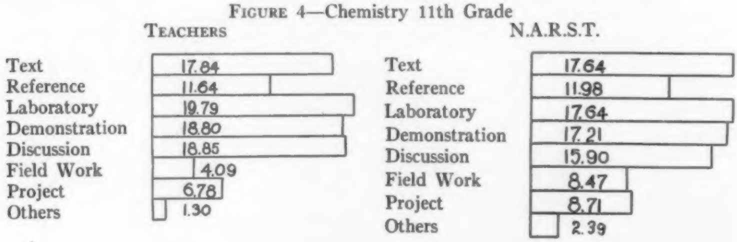
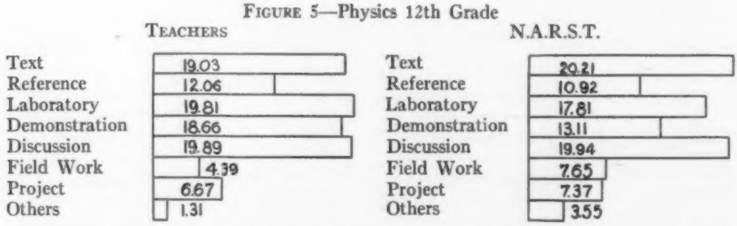


FIGURE 5—Physics 12th Grade



the junior-high-school level than in the senior-high-school. In the seventh and eighth years of the junior high school the demonstration method stands out as the method most used, both by teachers and supervisors. The following graph shows the correlation of the methods suggested by teachers and the N.A.R.S.T. group.

Teachers	*N.A.R.S.T.*
1. Demonstration	1. Demonstration
2. Discussion	2. Discussion
3. Text	3. Text
4. Reference	4. Reference
5. Project	5. Project
6. Laboratory	6. Field work
7. Field work	7. Laboratory
8. Others	8. Others

The close correlation reflects extremely well the close supervision in this new type of school which started frankly as an experiment and which still maintains an experimental attitude. In the opinion of the senior writer probably some of the best teachers of science are found in the junior high school because of the lack of imposed conditions on the teaching group.

At the ninth-grade level the correlation is not quite so close, but nevertheless it is quite noticeable. At this age level the discussion method comes first with the demonstration method a close second, followed by the textbook and reference methods.

Teachers	*N.A.R.S.T.*
1. Discussion	1. Discussion
2. Demonstration	2. Demonstration
3. Textbook	3. Textbook
4. Reference	4. Reference
5. Laboratory	5. Projects
6. Field work	6. Field work
7. Projects	7. Laboratory
8. Others	8. Others

A glance at Figure 2 discloses that teachers place much more emphasis on the textbook than does the N.A.R.S.T. group, and more relative importance is placed on the demonstration by the teachers than by the N.A.R.S.T. Field work and project work are considered more important at this age level by the N.A.R.S.T. than by the teaching group. The importance of reference material indicates that numbers of both teachers and supervisors see definite values in the so-called "Morrison Method" which tends to do away with the basic text in favor of reading from numerous references.

The striking tendency noticed at the senior-high-school level in the biology, chemistry, and physics courses is the relative importance attached to the textbook. At this level we should expect more emphasis placed on problem work, both through demonstration and laboratory and reference, and rather less emphasis on the use of the text, especially as many of the texts written at the higher levels of the secondary school are obviously poorly made from the standpoint of modern psychology. Chemistry and physics texts unfortunately reflect the college entrance situation all too strongly, but both answering groups emphasize the text to a surprising degree in the responses on chemistry and physics teaching.

The comparison of methods in elementary biology shows again a fair correlation between the teachers and the N.A.R.S.T. group. The discussion holds first place in both groups, with the text a close second in the N.A.R.S.T. group and the laboratory holding second place in the teaching group. The correlation is shown in the following table.

Teachers	*N.A.R.S.T.*
1. Discussion	1. Discussion
2. Laboratory	2. Text
3. Text	3. Demonstration
4. Reference	4. Laboratory
5. Demonstration	5. Reference
6. Project	6. Field work
7. Field work	7. Project
8. Others	8. Others

Chemistry shows the following correlation:

Teachers	*N.A.R.S.T.*
1. Laboratory	1. Laboratory or text
2. Discussion	2. Text or laboratory
3. Demonstration	3. Demonstration
4. Text	4. Discussion
5. Reference	5. Reference
6. Project	6. Project
7. Field work	7. Field work
8. Others	8. Others

The surprising item of this comparison is the remarkable emphasis placed on the textbook by the N.A.R.S.T. who weight the textbook and laboratory equally important with the demonstration closely following. The teachers group on the other hand places most emphasis on laboratory, showing their adherence to the old-line recommendations of the Committee of Ten.

In Physics the following correlation is shown:

Teachers	*N.A.R.S.T.*
1. Discussion	1. Text
2. Laboratory	2. Discussion
3. Text	3. Laboratory
4. Demonstration	4. Demonstration
5. Reference	5. Reference
6. Project	6. Field work
7. Field work	7. Project
8. Others	8. Others

Here again we see the surprising emphasis placed on the use of the text, particularly by the supervisory group. This is surprising in view of the eminently inadequate textbook situation in the upper grades of the sec-

ondary school. Is it that the supervisory group as well as the teachers are reflecting the propaedeutic function of the college entrance requirements? This is a question that cannot be answered without a careful study of the answers to the questionnaire. If one reads these carefully, he will be impressed with the emphasis placed by the supervisory group on the use of the method of science, on the development of the scientific attitude of the mind, and in general on the use of the technique of experimentation at the upper levels. It is probable that this *apparent* emphasis is only apparent, in that one of the larger aims at this level is mastery of science subject matter as well as attitudes.

The above material is submitted as indicative of certain tendencies in our science teaching. It appears that the teaching of science at the junior-high-school level is much less static than at the senior-high-school level; teachers are much more willing to experiment with their students, and are evidently approaching subject matter from the student angle. At the senior-high-school level, however, if one reads the answers to the questionnaire carefully, it is obvious that the work is much more formal, that teachers are much more concerned in teaching subject matter than in teaching children and that there is in many parts of the country pressure brought to bear by the colleges and universities for the acquiring of subject matter rather than of attitudes which should come from work in science. It is evident that even with our best leadership, there is room for improvement in science teaching at this level.

Project Work in Biology

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For the past six years I have stressed project work in my biology classes and have obtained some interesting results. I present in this article an account of some of my experiences with the sincere hope that they will be of some benefit to my fellow-teachers.

In the school in which I teach, biology is an elective subject, but once elected must be taken at least two semesters for credit. During the course of the year each student is required to construct some object or objects of biological significance.

The work of the first semester deals primarily with plants. Towards the end of the semester, as an introduction to the project work, students are given a talk somewhat as follows: "Class, we have been studying the structure and functions of plant parts and the economic importance of plants in the laboratory. We have studied these parts separately. Now I expect each of you to construct through any medium you desire, an entire plant. You must not only construct the plant, but must indicate as correctly as possible, the internal structure of the various parts, and accompany your project with a write-up of the history and economic importance of the particular plant chosen." As a means of stimulating interest, I tell them of the work of former groups; that, for example, one year a student made a beautiful model of the cotton plant. He, like most members of the class, had never seen a real cotton plant, so he went to the Department of Agriculture and secured pamphlets on cotton. With the aid of these pamphlets, encyclopedias, and certain reference books, he constructed a model that looked quite lifelike. He began by securing a many-branched maple twig which he intended to wind with crepe paper. When I saw him doing this I said, "We have studied types of branching, have we not?" Then his eyes were opened. He said, "Oh yes, I see, I have the wrong type of branch. The maple has opposite branching and it is alternate in the cotton plant. I suppose I will have to get an elm or an oak branch." With this beginning he completed his project, making the leaves, blossoms, and roots out of crepe paper, and using real cotton in the bolls. This model was accompanied by a handmade booklet containing labeled drawings of the internal structure of various parts, and an account of the history and economic importance of the cotton plant.

I explained to them that they need not limit themselves to the use of crepe paper, that they might express themselves through any medium

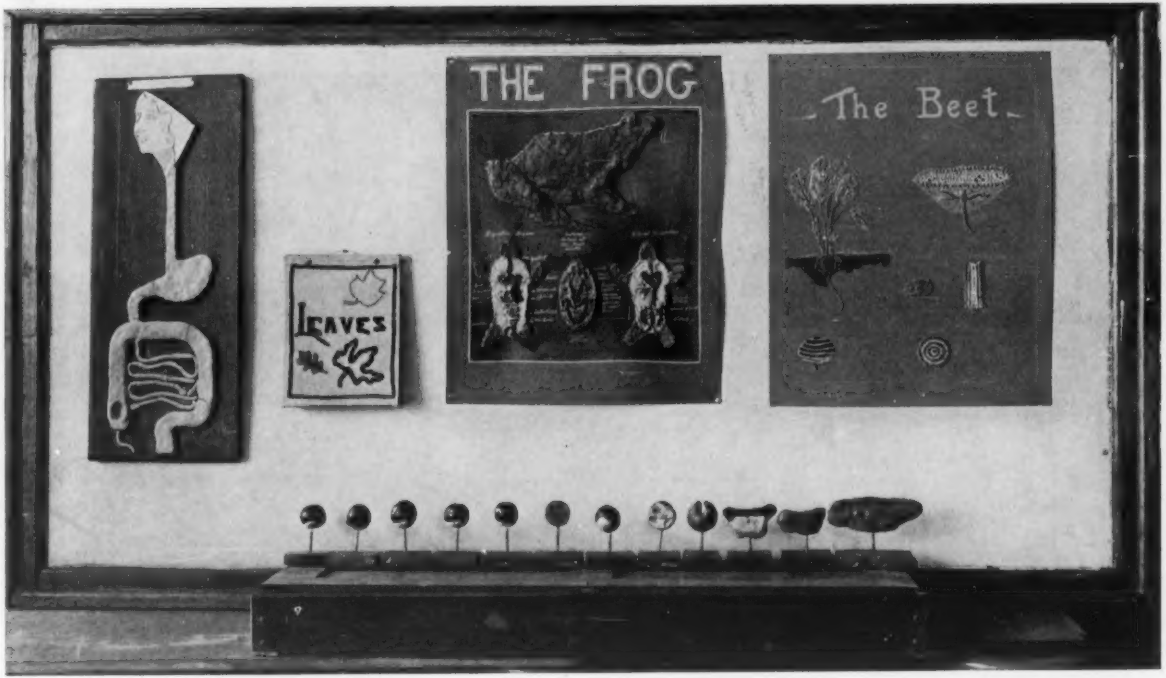

FIGURE 1

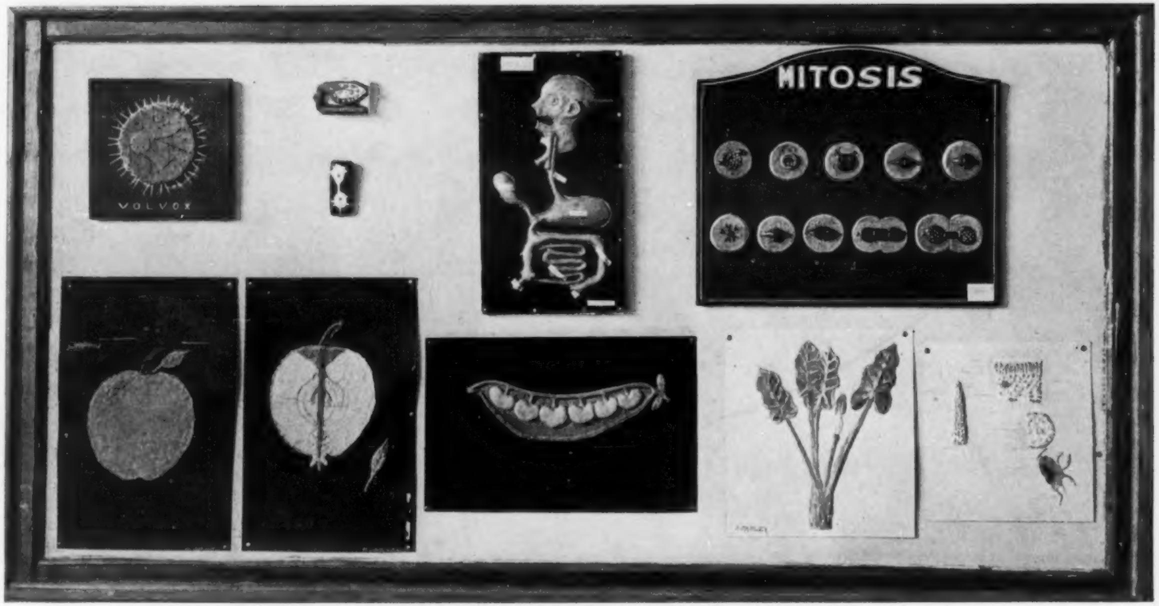

FIGURE 2

they desired. Some suggestions were clay modeling, wood carving, soap carving, paper and oil cloth cuttings, papier maché, embroidery, oil cloth stuffing, carving in linoleum, and other materials.

It is surprising what wonderful results may be obtained. An exhibit is held and the classes vote on the six best projects, and the owners give talks on their projects. In addition to these required projects students may do any others they desire.

Most of the work of the second semester deals with animals. Projects in this semester are voluntary. Here the better results are obtained. The student has had some experience in doing the required project the first semester. Besides, he seems to be more naturally interested in constructing animals than plants. See Figures 1, 2, and 3 for some of the projects.

In Figure 1 may be seen projects on the human digestive tract, leaves, the frog, the beet, and stages in the development of the tadpole.

The project on the digestive tract was made from ordinary modeling clay and glued on a board. Both were then painted the desired colors.

The cover of the book of leaves was embroidered on Monk's cloth.

The project on the frog was made of papier maché and painted the desired colors. This maché may be made from ordinary newspapers by placing them flattened out in water and allowing them to soak for several days. The soaked paper is then shredded by rubbing it between the palms of the hands or across a piece of screen wire. Enough water is added to make the maché of the proper working consistency. In this project the eye of the frog is represented by a shoe button.

The project on the beet was made of a mixture of salt and flour which was modeled on cardboard and painted. The student who made this project bought entire beet plants and dissected them in order to have an exact pattern by which to perfect his model. The entire plant and sections through its parts were all made of the salt and flour mixture. A very interesting paper on the beet accompanied this project.

The set of models shown at the bottom of Figure 1 illustrates important stages in the development of the frog to the tadpole stage. These were made of ordinary modeling clay. The pedestals were made from blocks of wood into which large nails were driven and the model made around the head of the nail. The gills in the last of the series were made from a piece of shoe leather cut into the desired pattern and inserted into the clay before it hardened. Models and pedestals were painted the desired colors.

Figure 2 shows projects on volvox, the earthworm, the amoeba reproducing by fission, the human digestive tract, mitosis, the apple (external


PROTOZOA
PORIFERA
COELENTERATA
ANNULATA
MOLLUSCA
ARTHROPODA
ARTHROPODA
PREVERTEBRATA
VERTEBRATA
VERTEBRATA

FIGURE 3

and internal structure), the bean pod, and the calla lily (external and internal structure).

The volvox was made of clay glued onto a wooden block and painted. The flagella are represented by toothpicks. This type of project might be improved upon by modeling the volvox colony around a piece of strong wire or a large nail placed on a base. This would give a more exact representation of the colony, as it would afford the illustration of volume.

The earthworm was carved from ivory soap, and then painted.

The amoeba showing fission was carved out of a block of wood. The white amoeba with a red nucleus, black stippling in the protoplasm, and green food vacuoles stands out quite attractively on a black background.

The projects on the digestive tract and the bean pod were made of permoplast clay on strong cardboard tacked to a wooden background.

The project on mitosis was made of modeling clay on a piece of beaver board tacked onto a wooden frame.

The projects on the apple and the calla lily were made of salt and flour on cardboard.

Figure 3 shows a portion of one side of the laboratory. The leaves, which were brought in by students in the autumn, range in color from green to red. They were pasted on with transparent adhesive tape, and make quite an attractive showing on a white background. The animal border was the project of a student in the second semester of biology. It represents an evolutionary series of animals. They were first drawn lightly with white chalk and then gone over with colored chalks to bring out their natural colors as nearly as possible. The student who did this border is quite an artist and has done several drawings for the *Washington Post.*

The animal posters were all done by one student in the course of the semester. They represent much work and are beautiful in their soft pastel colors.

Students are permitted to work on projects at home or at school. Most students like to do them. I have received many comments from parents who were delighted that their children had something worthwhile to utilize their leisure time.

The exhibits held at the close of the semester attract the attention of the faculty and the student body as a whole. The art teachers were particularly interested in seeing the possibilities of correlation between such apparently unrelated subjects as art and biology. English teachers were so delighted with the opportunity for vitalizing principles learned in their classes that they extend credit to those pupils who gave either oral or written compositions in connection with their project.

Academic Requirements Necessary to Teach Science*

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1. State Certification Requirements Necessary to Teach Science

Any attempt to formulate an adequate program of training for teachers of science must take into consideration present practices and probable tendencies. A wisely planned program of training for science teachers is possible only through an analysis of the history of science teaching, especially that of the last few years. The problem is, admittedly, a very complex one. Its ramifications lead into every field of educational thought and philosophy. The subject matter we are teaching in the classroom, the experiments carried out in the laboratory, the type of laboratory write-ups, the laboratory drawings—nay, even the subject matter divisions themselves—are the result of a psychology of education that attained its predominance in a period now gone. Tradition has a strong hold upon us. We can, at best, make progress but slowly. And it is probably best that this is so.

Leaders in science education will accomplish little if they advocate methods and programs too far in advance of the best thought of school administrators in the field. On the other hand leadership in science education must develop a tangible, workable program if secondary science is to hold its own. School administrators must look to someone for guidance in problems relating to science in the public school. They will turn to leaders in science education if they find that such leaders do have an adequate, workable program based on the best modern thought in education, psychology, and philosophy.

A program that meets these requirements has been formulated in the Thirty-first Yearbook of the National Society for the Study of Education. The committee in charge of this Bible of science education are to be most highly commended for the most notable contribution to science education that has ever been made. It will exert a tremendous influence in the science program of the public schools for many years to come. However let us not make too literal an interpretation of this Bible. That would lead to stagnation and defeat the very ends that the committee hopes to accomplish. Members of the committee would be the last to maintain that

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the Yearbook "Program for Teaching Science" is the final word. It does point the way to better science teaching. Along this way are many problems to be solved, as the committee has pointed out. Many of these problems are of such a nature that they may be solved in the relatively near future. Other problems will require more time, while a few of the problems may be incapable of a wholly satisfactory solution, but no doubt some progress will be made even with these almost intangible problems.

One obstacle to the immediate improvement of science teaching is the state certification laws of many states. A part of this investigation relates to the certification requirements for teaching science in the various states. Only by knowing present certification requirements can we make intelligent recommendations along this line. State certificate laws and regulations give a fairly complete picture of the practical demands made upon those entering the teaching profession in the secondary schools. This study is based on an analysis of handbooks, pamphlets, and letters from the state departments of education of each of the states. Subsequently each statement relative to a particular state's certification requirement was verified by the state superintendent of public instruction, the state commissioner of education, or a member of the state department. These requirements are listed alphabetically by states:

ALABAMA: Degree; 18 hours in education (including 8 hours in special methods, observation and practice teaching in major and minor fields). Major consists of 24 hours in science; minor consists of 18 hours. After 1932-33, major consists of 32 hours and minor of 24 hours—each with various options. Subjects of preparation written on face of license.

ARIZONA: Degree; 18 hours in education.

ARKANSAS: Special license in field taught. In science, 8 hours in each subject taught; general science must be 4 hours biological science and 4 hours physical science. May teach in two subject fields, such as science and one other field.

CALIFORNIA: Bachelor's degree plus one year college post graduate work; 18 hours in education (including directed teaching four hours). Science major of 24 hours and science minor of 12 hours, both of which must include some advanced work.

COLORADO: Degree; 20 hours education (4 hours practice teaching). Blanket license.

CONNECTICUT: Degree; 6 semester hours in subject taught; subjects written on face of certificate.

DELAWARE: Degree; 18 hours education (6 hours practice teaching). May teach subjects in which holder of certificate has specialized.

FLORIDA: By examination, if applicant has had two years college work in those subjects (agriculture, physics, chemistry or biology).

Degree; License to teach science if applicant has had 6 hours each of biology, physics and chemistry and has had subject in high school. Biology, physics or chemistry written on certificate if applicant has had 12 hours in subject. General science written on license if applicant has had two high school units in science and 12 hours college science—must have had general science or physics in high school or college.

GEORGIA: 60 hours college work required. Subjects written on face of license; usually require 9 to 12 hours in subject.

IDAHO: Degree; 10 hours professional education. General license.

ILLINOIS: Degree; license in physical science or biological science—16 hours in either field, including 8 hours in subject taught, or 5 hours if a half-unit course. Biology teachers are expected to have 5 hours each in botany and zoölogy.

INDIANA: Degree; 15 hours education (3 hours student teaching). Science Options:

First Option—36 hours

Biology—15 hours (or botany 7½ and zoölogy 7½), chemistry—15 hours, physics—15 hours, any two of three above and physical geography—6 hours or physiology—6 hours. License to teach subjects in which credits are offered and also to teach general science.

Second Option—25 hours

Biology—20 hours (or botany 10 and zoölogy 10), physiology—5 hours, license in subjects named.

Third Option—25 hours

Physics—10 hours, chemistry—10 hours, physical geography—5 hours. License to teach subjects named.

Fourth Option—20 hours

License to teach either biology, botany, zoölogy, chemistry, physics, physical geography, or physiology if 20 hours credit offered in any one of them.

Fifth Option—48 hours

Following combinations may be offered if at least 24 hours in each of the two: Physics and chemistry; physics and geology; chemistry and biology.

IOWA: By examination or credentials. Temporary if two years of college work and half of high school teachers have degrees.

Degree; 14 hours education. License shows training in subject desired to teach; recommend 10 hours in subject taught.

KANSAS: Degree; 18 hours education. General license. Class "A" high schools require teachers to have preparation in subjects taught, at least equivalent of 20 hours, 10 hours of which may be high school credit.

KENTUCKY: Provisional high school license issued upon completion of 64 college hours including 12 hours of education—may teach any subject.

Degree; 12 hours education including Practice Teaching gives standard blanket license. Good for life if 24 hours education and 3 years experience.

LOUISIANA: Degree; 12 hours education (4 hours practice teaching); license in subjects specialized—at least 12 hours required in each subject.

MAINE: Secondary Nonprofessional Certificates:degree; blanket license.

Secondary Professional Certificate: Degree; 18 hours education; blanket license.

MARYLAND: Degree; 16 hours education (4 hours special methods and practice teaching).

Physics—18 hours, chemistry—18 hours, biology—18 hours, or high school science—24 hours (12 hours in one science and 6 hours at least in each of the above three).

MASSACHUSETTS: Degree; 6 hours education; 2 majors or one major and two minors (major—12 hours; minor—6 hours): biological science (biology, botany, physiology, zoölogy, and hygiene) or physical science (physics and chemistry). Applies to state-aided schools only.

MICHIGAN: Degree; blanket license. Accrediting of high schools though institutions of higher learning compel high school teachers to teach only in major or minor fields.

MINNESOTA: Degree; 15 hours education including practice teaching and special methods. May teach fields for which specifically prepared, must be in major or minor fields. (Minor consists of at least 12 hours).

MISSISSIPPI: Two years college work; 12 hours education. Blanket license. State Department advises that teachers teach only subjects for

which they are trained. Science requirements are now 20 hours, but will be raised to 36 hours in 1936-37.

MISSOURI: Minimum of 90 hours of college work; 15 hours education; Blanket license, good for one year.

Degree; 18 hours education including 3 hours observation and practice teaching. Blanket license good for five years.

MONTANA: Degree; 14 hours education. General License.

NEBRASKA: Two years college work; 12 hours education; 12 hours in each of two subjects.

Examination grade of 80 in each of certain subjects: (includes botany, physics, chemistry, and general science).

Degree; 15 hours education. Permanent license of blanket type.

NEVADA: Degree; 18 hours education including 4 hours practice teaching. General license.

NEW HAMPSHIRE: Degree; 12 hours education; examination in field.

Master's degree; 24 hours education; no examination in field.

NEW JERSEY: Degree; 15 hours education including 6 hours practice teaching. Science license if applicant has had 12 hours science or specific science license such as chemistry if applicant has had 3 hours.

NEW MEXICO: Degree; 15 hours education including special methods; must have 6 hours in subject taught.

NEW YORK: Degree; 18 hours education including 6 hours special methods, observation, and practice teaching. Blanket license. State Department advises at least 15 hours in subject taught. Beginning to certify teachers to teach specific subjects.

NORTH CAROLINA: Degree; 16 hours education including 9 hours practice teaching and special methods. May teach only in field of preparation stated on license.

Science (30 hours) may be in one science. Recommend 36 hours with at least 6 hours in each of 4 sciences.

NORTH DAKOTA: Degree; 16 hours education including practice teaching and special methods. Blanket license but must teach in major and minor fields.

OHIO: Degree; 15 hours education including 6 hours special methods.

Physical Science major—18 hours; minor 10 hours. (Minor is 10 hours in physics and chemistry).

Biological Science major—18 hours; minor 10 hours.

May teach only these subjects and must have 6 hours in subject taught. Also may take local examination for local certificate to teach science.

OKLAHOMA: Ninety hours college work; 12 hours education including 2 hours practice teaching; 16 hours in field applicant wishes to teach.

General science—16 hours (at least 4 hours each of chemistry, physics, and biology).

OREGON: Degree; 15 hours education including 2 hours practice teaching; general certificate.

PENNSYLVANIA: Eighteen hours education including 6 hours practice teaching.

Subjects specifically written in license (18 hours in subject). May be physical science or biological science. Course completed through correspondence not accepted after September 1, 1932.

RHODE ISLAND: Degree; certain courses in education. General license.

SOUTH CAROLINA: General license. Proposed after 1934: degree; 18 hours education; 12 hours in subject taught.

SOUTH DAKOTA: Degree; 15 hours education including 3 hours practice teaching; at least 3 semester hours in subject taught.

TENNESSEE: Degree; 18 hours education; at least 12 hours in science if licensed to teach science, with at least 6 hours in subject taught. May teach general science if 6 hours in each of two of the following: biology, physics, and chemistry. May also take examination under certain conditions.

TEXAS: Several classes of certificates issued. Two-year high school certificate issued upon completion of 5 full college courses including one course in English and one course in education. Permanent certificates issued upon graduation from college if certain requirements are met. High school certificates of the second class may be granted upon satisfactorily passing a written examination.

UTAH: Degree; 18 hours in education. General license. State board strongly recommends that in so far as possible teachers be required to teach only those subjects in which they have majored or minored. Major consists of 20 hours and minor 12 hours.

VERMONT: Two years college work; 6 hours education. General certificate.

VIRGINIA: Degree; 18 hours education including 6 hours practice teaching; 24 hours in science (8 hours in each of 3 sciences: biology, physics, chemistry, geography)—may then teach these subjects in high school. If the 24 hours are in the first three named subjects, the applicant may teach all sciences in high school.

WASHINGTON: Degree; teachers must teach in major or minor field. After 1931, high school teachers must offer work beyond 4 years in college up to five years of college work; 16 hours in education.

WEST VIRGINIA: 3 years college work gives provisional certificate. Physical science—24 hours (12 hours each in physics and chemistry).

Biology and general science—24 hours (8 hours each in biology chemistry and physics).

First class certificate:

Physical science—32 hours (16 hours each in physics and chemistry).

Biology and general science—36 hours (biology 20 hours; chemistry and physics 8 hours each).

WISCONSIN: Degree; 15 hours education including 4 hours special methods.

General license or general science license (5 hours each in physics, chemistry, and biology)

Biology license—15 hours

Chemistry license—15 hours

Physics license—10 hours

WYOMING: Degree; General license, State Department advises at least 15 hours in subject taught.

Standards of the North Central Association of Colleges and Secondary Schools, relating to the preparation of teachers, states that "all new teachers of academic subjects in accredited schools must teach only in those fields in which they have adequate preparation . . . the following are desirable minima . . . science 15 semester hours, of which five shall be in the science taught." The number of secondary schools accredited by the North Central Association was 2414 in 1931.

The Committee on Standards of the Southern Association of Colleges and Secondary Schools at the December, 1931, (Montgomery) meeting recommended that "beginning teachers of academic subjects . . . are required to have degrees from colleges approved by the association and should

not teach outside the fields of their college specialization" " . . . 67% of beginning teachers teach wholly in major or minor fields, while only 6% teach outside their major or minor field." In 1930 there were 1175 secondary schools belonging to the Southern Association.

All states issue certificates of one kind or another. Massachusetts issues state certificates only to teachers teaching in state-aided schools. Thirty-six states now require a degree for state certification. Many states that do not, have certain restrictions. One state (California) requires one year of college work beyond a degree, while Washington requires work beyond four years in college up to five years in college. About half of the states require courses in practice teaching methods, the range being two to eight hours with median of about five hours. About fifteen hours of education are required, the range being zero to twenty-four hours.

Evidently there is still a presumption on the part of some that anyone with a college degree can teach in high school. About half of the states issue blanket certificates entitling the holder to teach any subject from Esperanto to barnyard golf. This practice of issuing blanket certificates is one of the most deplorable conditions relating to state certification. It is a practice that can be and should be eliminated as soon as possible. This practice may not be as bad as an analysis of the state certification requirements would tend to show. In some states, the state department of education, and, in other states, the institutions of higher learning, modify this practice by requiring teachers in high school to teach in the fields of their major and minor work. Michigan is an example of the latter type of state. Other states issuing blanket certificates make certain recommendations along this line. No doubt these recommendations often become, in reality, state rules.

On the other hand, conditions may be worse than indicated. Certain studies relating to the major and minor preparation of teachers and the subjects they are teaching would seem to indicate this. They have certificates in one subject, yet are assigned to teach something else. Undoubtedly blanket certificates tend to lower the standards of teaching. Unscrupulous superintendents (and there are still a few of these) and politics are aided and abetted by blanket certificates and lax state standardization practices. That the states themselves recognize the inadequacies of blanket certificates is found in the fact that six states officials in letters to the author rather apologized for these blanket certificates.

(Part II will conclude this article in the April issue.)

Physics In Relation to Manual Arts in Sweden

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Manual arts of all types are collectively known as sloyd in the Scandinavian countries. In various forms it has been a part of the school curriculum in Sweden for many years. At first the old native sloyd occupations were followed, such as carpentering, woodcarving, bookbinding, and work in copper and iron, but later the industrial element gave way to a well-organized course in educational tool work for boys. Recently a new type of sloyd instruction in which the subject is combined with physics has made its appearance in both Sweden and Denmark.

Physics-sloyd in its general meaning is nothing new. There has always been some construction of physics apparatus in the schools. The difference, however, in this course is that the apparatus construction has been transferred from the physics laboratory to the shop. The idea has been enthusiastically received in these countries, and the subject is now seeking recognition as one of the branches of shop work.

In Sweden this work had its beginning at the Gothenburg State Normal School for Elementary School Teachers. Some years ago the teacher of physics at this school saw the need of giving training to the prospective teachers in the construction and the repair of physics apparatus. The normal school students were already receiving instruction in physics as well as in chemistry and biology. (All of these sciences are taught in the elementary schools of Sweden more extensively and earlier than in this country.) Through the coöperation of the shop (sloyd) teacher and interested students, the idea took more definite form, and later it became an established part of the shop work in this school. The results of several years of study and experimentation by these two teachers have been made available in a book,[1] which in turn has been translated into several languages. The book consists of over 140 exercises, each containing a drawing of some physics apparatus and instruction for making and using the same. A few of the exercises deal with chemistry.

This new subject permits a combination and concentration of subjects. Sloyd, which had in most instances been largely wood sloyd and consequently one-sided, now is supplemented by this new addition. In physics-sloyd we have the rare combination into one course of the separate arts of paper, wood, and metal sloyd. This arrangement gives the instruction in both the sloyd and the physics valuable assistance and added stimulus.

The work is at present carried on in several types of schools. At some

of the normal schools it is now taught both as one of the regular subjects and as a summer course to elementary school teachers actively engaged in their profession. The subject is also being introduced as a part of the first physics instruction in the elementary and intermediate schools, these being the schools for which it is primarily intended. The work in the summer sessions is furthest developed and will be discussed more fully.

For the past five summers several courses have been given at various normals schools in Sweden and Finland. The writer had the opportunity recently to visit and observe the work during one summer at the Gothenburg Normal School. This session may be considered typical. It is held for three weeks with six hours each day devoted to this one subject. The first two weeks are given entirely to sloyd, during which time a large variety of physics apparatus and material is made by the teachers enrolled. The sloyd instruction is first given in paper, wood, and metal work which is then followed by the actual making of apparatus. Some time is devoted to methods in sloyd instruction and to desirable information in regard to tools and materials. The third week is given to physics instruction which pertains specifically to the use of the apparatus and to the planning of the laboratory work—all of this as it particularly pertains to the physics instruction in the elementary school.

The course is of special value to teachers in schools which are handicapped by insufficient physics equipment. More important, however, is the fact that this subject-combination has definite pedagogical values. One of the purposes of this instruction is to give the child something with which it can itself be occupied, for, as Mr. Nilsson, the physics instructor, has stated, "if the instruction in physics is to have the developing and educational qualities which it should have, it is necessary that the self-activity of the child be used." The course of study in the Swedish elementary school indicates how this self-activity may be applied. "The pupils should, wherever possible, perform the experiments themselves" and "for the purpose of creating interest and making it easier for the pupil to understand, as well as for the development of their practical abilities, it is of significance that they themselves make simple apparatus and experimental preparation to the extent possible." Further, it gives the pupil an opportunity to increase his adaptiveness, to use his inventive abilities, and to become more acquainted with a variety of materials.

It was with these ideas in mind that the two teachers entered upon the work of selecting appropriate experiments the apparatus for which could be constructed by the pupils in the elementary school under the guidance of a teacher who had received training in a summer course or who could follow the instructions as outlined in the book. They then worked out

apparatus which could be made with a minimum amount of ability, time, and expense, and which, at the same time, would be valuable in illustrating some particular element in physics.

The apparatus made during the session which the writer visited was representative of each of the important divisions of physics. The list includes scales, springs, siphons, levels, boomerangs, turbines, steam engines, electroscopes, electromagnets, galvanometers, motors, cameras, and so forth. Altogether 843 pieces, representing 89 different types of apparatus, were made in the first two weeks of this course. There were enrolled twenty-five members, including five women. A large number of them had had little previous training in shop work or in the use of tools, and yet in this brief time they were able to master the necessary essentials.

This combination of physics with sloyd may be considered one of the best educational practices in science teaching which Sweden has developed. It is true that other countries, notably Denmark and Germany, have work of somewhat similar nature, but it is in Sweden that it has been carried through in the best and most practical way from the standpoint of science education. Lektor Thorup has worked along similar lines in one of the Danish schools, though with the difference that his type of instruction is intended more for sloyd itself than for physics, and is especially of value in schools where instruction is given in metal sloyd; in contrast to this, the apparatus developed by the Swedish educators is intended primarily for use in the performance of experiments.

Through the efforts of the aforementioned individuals, physics-sloyd has been raised from a position of a pastime for the students to an important pedagogical subject. What at first was a temporary combination of subject matter has now become a productive and worthwhile subject.

An introduction into the American schools of similar work should be of benefit to our educational programs in both the physical sciences and the manual arts. The general science in the elementary grades and the junior-high school, and the physics in the senior-high school, would especialy profit from it, provided the necessary correlation between the shop and the science instruction could be effected.

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The Micro-Projector Compared With the Individual Microscope in Teaching High-School Biology

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Educators easily recall, when the function of content outweighed the function of method to the extent that if content was properly chosen, method was supposed to care for itself. The teacher used that method common to his past experience, and the scientifically checked method did not exist. The problem was more what to teach than how to teach. Teaching is becoming a science, and method, as well as content, a problem of the research worker.

It has been customary to employ the individual microscope in teaching high-school biology. In schools where this subject is required, class enrollment is usually large and equipment expensive. Let the teacher figure the cost of good microscopes for a class of thirty. A conservative estimate would be $550.00. A good micro-projector capable of projecting anything that can be seen with the microscope sells for $220.00.* In addition to the initial saving, reduction in the number of slides should be considered and also the saving of time to the instructor and pupil. The question, then, becomes one of determining the relative achievement of pupils taught by the contrasting procedures. To this end the experiment herein reported was undertaken.†

Under what situation do pupils achieve the more—through the use of the projection of miscroscopic slides or that of the individual microscope?

The equivalent-group method was used in the experiment. Pairing was on three bases: chronological age, intelligent quotient, and average class achievement weighted by accomplishment in biology. The Otis self-administering intelligence test was used. The central tendency and variability of the two groups on the bases of the three measures are given in Table I. No significant differences exist between the groups with respect to the three characteristics.

Specially designed study guides were used for both the experimental and control groups. The experiment lasted over a period of twelve weeks, and both groups had equal advantages in every respect except the method of observation of the specimen on the slide. The observation in the control group was by the use of the individual microscope. In the experimental group the

* For details of equipment refer to Chicago Apparatus Company, Chicago, Illinois.

† The study constituted a partial fulfillment of the requirements for the degree of Master of Arts attained at West Virginia University in 1932.

TABLE I

PAIRING OF GROUPS

	Control Group				*Experimental Group*		
	C.A.	I.Q.	Av. Ach.		C.A.	I.Q.	Av. Ach.
M.	15–11	99.0	79.0	M.	16–2	98.5	79.0
S.D.	1.2	12.04	4.35	S.D.	1.6	11.13	4.24
S.D.M.	0.22	2.2	.82	S.D.M.	.3	2.1	.8

S.D. of C.A. = .37 $\frac{D}{S.D.D.}$ = .67

S.D.D. of I.Q. = 3.0 " = .16

S.D.D. of Av. Ach. = 1.1 " = .0

TABLE II

SUMMARY OF FINAL COMPARISON OF GROUPS

Control Group		*Experimental Group*		*Gains*
No.	*Av.*	*No.*	*Av.*	
1	66	1	70	4
2	57	2	59	2
3	61	3	74	13
4	60	5	54	—6
5	49	8	58	9
6	63	4	57	—6
8	64	6	75	11
9	57	11	63	6
10	70	14	76	6
11	57	7	64	7
12	67	10	67	0
13	54	17	63	9
14	47	12	51	4
15	55	9	66	11
16	34	19	71	37
17	35	15	49	14
18	55	13	62	7
19	66	23	61	—5
20	44	16	47	3
22	57	18	66	9
23	35	20	67	32
24	50	26	74	24
25	29	25	52	23
26	48	22	62	14
27	39	28	56	17
28	39	27	54	15
29	38	29	53	15
31	62	24	62	0

C. Group	*E. Group*	
Av. 52	Av. 62	Difference in gains: = 10
S.D. 11.4	S.D. 7.8	N = 28
S.D.M. $\frac{11.4}{\sqrt{28}}$	S.D.M. $\frac{7.8}{\sqrt{28}}$	

observation was made from the slide projected on a white screen. This meant a detailed, correct, and directed observation.

The following slides were studied, a study guide being used for each.

I. Amoeba and Paramecium
II. Grantia and Commercial Sponges
III. Hydra and Colonial Hydroid
IV. Planaria and Tapeworm
V. Ascaris, Trichinella and Hookworm
VI. Platyhelminthes and Nemathelminthes
VII. Starfish
VIII. Insects
IX. Clam Gill
X. Amphioxus

The tests were based entirely on the study guides and what the observer had viewed. True-false drawing- and labeling-items constituted the tests. In most cases the pupils were required to draw and label what they had observed. These tests were scored by the same instructor and were objective as to answers and scoring. It is seen that no tests were available other than those devised by the instructor, since the tests had to apply to the particular situation at hand. No source of material studied was available except as given out by the instructor. The pupil had no other chance to view the specimen than that presented on the slide. Tests were given only at the end of the experiment. Since students in both groups were unable to identify the organisms on the respective slides previous to instruction, it was assumed that a pre-test was not essential to determine their initial status. A total of seventeen slides were used. The tests were all given on an equal basis, and all unreliable subjects were omitted from the experiment. The results of the twenty-eight pairs remaining from the original thirty-one were carefully checked, and a record of each group was kept through the ten tests given. A summary of these records is given in Table II.

The total of score points gained by the control group was 1458, and that of the experimental group was 1733, making a difference of 275 score points in favor of the experimental group, or an average of ten points per pupil. The same result is obtained by adding the positive and negative gains of the gain column, and dividing by N or 28.

The reliability of the difference known in the table as S.D.D. was found by the formula,

$$\text{S.D.D.} = \sqrt{(\text{S.D.M.}_1)^2 + (\text{S.D.M.}_2)^2 - 2r(\text{S.D.M.}_1)\cdot(\text{S.D.M.}_2)}$$

It should be noted here that this formula takes into consideration the correlation of the traits in question. Unless it is reasonable to assume that x and y are independent traits, or at least uncorrelated traits, the use of the shorter formula for S.D.D. can not be justified, and will give rise to erroneous con-

clusions.[1] In this case the traits in question were the final test scores, the initial test scores being zero. The correlation was found to be : $r = .50 \pm .095$

Substituting in the above formula,

$$\text{S.D.D.} = \sqrt{\left(\sqrt{\frac{7.8}{28}}\right)^2 + \left(\sqrt{\frac{11.4}{28}}\right)^2 - 2(.50)\left(\sqrt{\frac{7.8}{28}}\right)\left(\sqrt{\frac{11.4}{28}}\right)} = 1.9$$

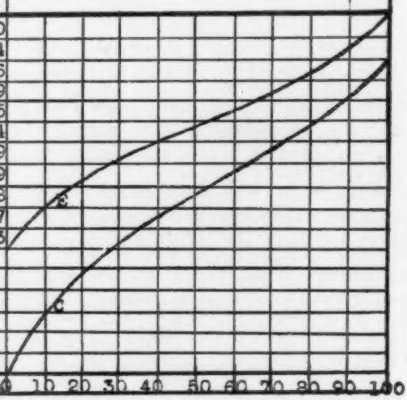
$$\frac{\text{obtained difference}}{\text{S.D. difference}} = \frac{10}{1.9} = 5.3$$

In order that a clearer trend of the results may be interpreted, a percentile graph of the control and experimental groups is given in Chart I.

Chart I

Percentile Graphs of Control and Experimental Groups

Percentile Ranks. of (tops)	C	E
75-77		100
72-74		94
69-71	100	86
66-68	97	79
63-65	86	65
60-62	79	54
57-59	68	39
54-56	54	29
51-53	43	18
48-50	43	7
45-47	32	3
42-44	29	
39-41	25	
36-38	18	
33-35	14	
30-32	3	
27-29	3	



Since a $\frac{\text{obtained difference}}{\text{S.D. difference}}$ of 3 is indicative of complete reliability,[2] it may be affirmed that the results obtained in the experiment would indicate with practical certainty the existence of a true difference in favor of the experimental group if the experiment were to be repeated under the same conditions.

Just how much the results here obtained depend on certain factors influencing these results no one knows. Possibly pairing should have been on another basis. There is no agreement as to just where mental growth ends, and possibly raw scores would have been more exacting than I.Q.'s. Such

factors might have entered into pairing as sex and eyesight with many others. Should we pair on any particular number of factors? Just what weight should be given to class marks?

Equivalence of groups does not require that all subjects, participating in the experiment, be equivalent, but it does mean that all groups participating be equivalent. To be equivalent the various groups must have like means and like variability among the subjects constituting each group. This was taken care of by having for every individual in one group an equivalent individual in the other group. The equivalence need not be necessarily an intelligence, education or experimental trait, but it is necessary that the groups be equal in their possibilities for growth in the trait in question.[3] However, at the best we know little about just what sort of measurement will yield, as a basis of selection in a particular experimental situation, groups equivalent in their possibilities for progress. While much research is needed it is not profitable to discuss the question at greater length at this point.

The results of the experiment have been so far-reaching that even after reasonable discount, there are strong implications for the use of the micro-projector as an improved teaching device over the individual microscope for high-school pupils. A correct detailed observation with group discussion under the direction of the instructor prevails. Instead of only one individual viewing the specimen, a class views it as it really is; not haphazardly but directed.

$$\text{Since superiority} = \frac{\text{Experimental Score—Control Score}}{\text{Control Score}}$$

$$\text{Superiority} = \frac{62-52}{52} = .19 \text{ or } 19\%$$

The superiority with the saving of time (50–75%) (depending on equipment) to the school and instructor means that due consideration must be given to such a method in high schools where biology is taught.

References Cited

[1] Walker, Helen M. "Concerning the Standard Error of a Difference." *Journal of Educational Psychology* 20:54, January, 1929.

[2] Garret, Henry E. *Statistics in Psychology and Education*, p. 133.

[3] McCall, William A. *How to Experiment in Education*, p. 29.

The Organization of Science Teachers in the Middle States

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Our present society is supposed to be one in which the majority controls, but all of us know that the wishes of unorganized majorities are continually thwarted by small but closely organized minorities. An individual is powerless, excepting as he is in some fashion joined with others for common action. It is in recognition of these facts that teachers have joined themselves into various associations which serve both to express the collective will of the group and also to allow opportunity for the discussion of professional topics.

The science teachers of the Middle States have created many very effective local organizations, as in New York City and in Philadelphia. The work of these groups for the professional advancement of their members is sufficient proof of the advantages of organization if such proof is needed. The only fault to be found is that such organizations are of necessity strictly local, and the large number of science teachers outside of metropolitan areas are practically without the benefit of organization.

There is at the present time no organization that represents the interests of the science teachers of the Middle States as a whole, nor any meeting which brings them together for exchange of views. There are, of course, state science teachers' associations, but the writer's experience with several of them, both in this region and in other places, indicates that they do not bring together any large portion of the teachers and in any case cannot offer the stimulus which comes from contact between persons with the different viewpoints offered by the several states. There is also the Department of Science Instruction of the National Education Association but the long distances to be traveled to its meetings and the changing clientele from year to year have prevented it from becoming as influential as was hoped. There also exists the Science Association of the Middle States, operating as a section of the Association of Colleges and Secondary Schools. Like the other organizations mentioned, it has failed to centralize the interests of science teachers, though it has been doing influential work in its field.

The situation in the Middle States is quite different from that in some other parts of the country where vigorous regional associations are in existence. As an example, one thinks of the Central Association of Science and Mathematics Teachers with an active membership of more than a thousand.

The great concentration of population in the Middle States offers greater opportunities than are to be found in any other section of the country.

Several types of organization are possible. The most obvious type is one based upon individual membership. It has the advantage of direct relationship with its members and of their personal interest in the association. It reaches the isolated teacher of the rural high school as intimately as it does the one in the large urban school. There is the corresponding disadvantage that it adds another to the long list of societies and membership dues to which each of us feels obligated.

Another type of organization associates the local societies with itself under some form of affiliation, the central organization serving as an integrating agency. In this fashion the existing societies may be brought quickly into relation with each other, but the teachers who are remote from the greater centers of population are not included. It also necessitates a division of membership fees between the central and local organizations and creates very little interest of individual members in the central organization. Various combinations of individual and institutional membership will suggest themselves as practical under particular circumstances. The writer has no intention of advocating any specific type of organization. It is the function of this article merely to point out the need and suggest some of the possibilities.

Whatever type of organization might be adopted, its success would appear to depend upon the existence of a small group of professionally-minded science teachers who would agree to stick together and to promote the organization through a term of years. Conversely, with such a coherent group as a nucleus, almost any type of organization would succeed.

The Science Association of the Middle States might afford a starting point for organizing science teaching in this region. It is a going organization and by its relation to the Association of Colleges and Secondary Schools, it has an assured position and a definite relation to certain important problems. At any rate it is glad to offer its facilities as a center of correspondence and discussion for the science teachers of the region if they care to take up the matter, and this offer is made quite without prejudice in the question as to whether this association may or may not be used as the nucleus for further developments in the interests of the science teachers of this region.

The writer invites correspondence on the question of organization and, if there seems to be a demand for action, will be glad to offer facilities for the meeting of a representative committee. The executive committee of the Association will also be glad to arrange the program of the next meeting of the Association to provide opportunity for full discussion.

Abstracts 

General Education

WILSON, F. T. "Similarity in the Learning of Dull and Bright Children." *Educational Administration and Supervision* 18:549-555; October, 1932.

A considerable number of studies are reviewed, comparing the learning of bright and dull children, and pointing out the significant fact revealed by all of them, namely, that the difficulty which bright and dull pupils experience in learning processes of various sorts is one of degree rather than of kind; that in general both groups progress in the same way, make the same sort of errors, and find the same sorts of tasks difficult. The bright pupils make fewer errors, master the difficult tasks more easily, and progress faster than the dull pupils. The author concludes, "There seems to be no reason to believe that fundamentally different methods of learning should be provided for dull and bright children respectively. The tempo differences and those in complexity might be very great, however. . . . The main problem of teaching is to meet the particular needs of individuals. It is not an administrative one of grouping people who chance to be somewhat alike in a bit of achievement and then handing out to them all alike a uniform course and method for learning it." Basic methods should always be modified to meet the individual need. —F.D.C.

COREY, STEPHEN M. "The Present State of Ignorance about Factors Effecting Teaching Success." *Educational Administration and Supervision* 18:481-490; October, 1932.

The author briefly reviews a great number of studies comparing teacher rating and prediction of teaching with actual success of those who were rated and whose success was predicted. He summarizes his discussion of these studies thus: "Actually we know next to nothing about what factors in the teacher's equipment make for rapid and permanent pupil learning. The outlook is discouraging in the extreme. . . It is conceivable that we are doing almost nothing in our teacher training which will actually contribute to efficient instruction. At least we have little, if any, valid, objective evidence as to the value of our practices. It should be at present impossible for any conscientious individual to advise students whether or not they should continue training for teaching. Despite our prejudices and deeply rooted convictions, the critical thinker will realize that, beyond some obvious physical handicaps such as blindness, deafness, or an extreme speech defect, we have no sound evidence to justify our recommendations." —F.D.C.

DAGGETT, CLAY J., and PETERSEN, FLORENCE A. "A Survey of Popular Plans for Instruction." *Educational Administration and Supervision* 18:499-522; October, 1932.

A brief but careful and systematic survey is made of the Morrison Plan, Winnetka Plan, Dalton Plan, Pueblo Plan, Batavia System, Multiple Track Plans, and the Platoon System. The authors treat each of these plans under six headings, History, Objectives Peculiar to This Plan, Requisites, Procedure, Advantages, and Disadvantages. The discussion of each plan is followed by a selected bibliography. —F.D.C.

HILL, CLYDE MILTON. "The Depression Makes New Demands upon Craftsmanship in Teaching." *California Quarterly of Secondary Education* 8:5-11; October, 1932.

As his thesis the author states that the only hope of maintaining the efficiency of our schools, in the face of the various

exigencies and curtailments due to the depression, lies in maintaining and even increasing our teaching efficiency. This can be done only by eliminating the less capable teachers and by filling all vacancies with superior teachers. He cites these criteria as guides in the selection of such teachers: Has the individual a good teaching personality? Is she an educated person—with respect to *general* scholarship, culture, and refinement? Does she have a knowledge of the subject matter to be taught? Is she a master of the skills to be imparted? Has she a clear vision of the ideals to be passed on? Has she mastered the art of teaching? Has she technical knowledge? Has she technical skill? Has she teaching insight and resourcefulness? Has she professional ideals and attitudes? —F.D.C.

SPINDT, H. A. "What the Principal Expects of the Teacher." *The High School Teacher* 8:328-360; November, 1932.

This article adopts the point of view that pupil judgment of teachers is, in general, accurate. The further implication is that the principal expects the teacher to live up to these pupil judgments. There follows a list of personality traits which pupils dislike in teachers and a second list of desirable general traits quoted from a study of F. W. Hart of the University of California. The first list may be useful to the teacher in self-checking. Such discussions always leave the reader with a desire to have some one present constructive suggestions to teachers on how to build up desirable personality traits. —R. K. W.

BOWERS, FRANCES. "What the Teacher Expects of the Principal." *The High School Teacher* 8:329, 360; November, 1932.

The following seem to be the major expectations according to Miss Bowers: (1) supervision and criticism of general teaching but not expert advice in special subject-matter fields; (2) as an adult listener, a reporting of the affect of the presentation of subject matter on pupils; (3) a court of last resort on disciplinary problems; (4) ultimate sponsoring of all school activities; (5) caring for special problems of boys, as dean of boys; (6) acting as a buffer between teachers and parents; (7) serving as a barometer of community attitudes; (8) partnership in the problems of teaching; (9) help in securing needed physical equipment; (10) unification and co-ordination of the various activities of the school.
—R. K. W.

NICHOLS, FREDERICK G. "Teaching a Fine Art." *Education* 53:6-15; September, 1932.

In the address delivered by Professor Frederick G. Nichols of Harvard University, to students and instructors in the Harvard Graduate School of Education, Professor Nichols urges those who wish to become successful teachers to prepare themselves adequately in the subject to be taught and to be well trained professionally. In addition, he urges students to study their qualifications to the end that they may become artist teachers. In this respect he suggests the possibility of increasing ability through "intelligent, effective, and voluntary coöperation" in the activities of co-workers; by individualizing instruction although working with classes containing large numbers of pupils; by performing duties which previously had been exclusively the function of parents; by avoiding the imposition upon pupils of personal ideas relating to significant religious, social, and personal problems; by controlling activities in such a way that the greatest possible good can be exerted in the community; and by idealizing students but, at the same time, being cognizant of their weaknesses. —F.G.B.

PATERSON, HERBERT, "Trends in the Offering of Oklahoma High Schools, 1921 to 1931." *Peabody Journal of Education* 9: 349-354; May, 1932.

This study is based upon the unit offerings of Oklahoma high schools not included in the North Central Association, 389 schools in 1921 and 713 in 1931. Interesting trends and changes are as follows: the percentage of schools offering Latin has decreased from 80 to 20.8; for French from 22 to 2.9; for physics from 43.9 to 19.6; for botany from 30.3 to 0.9. The percentage of schools offering biology has increased from 0 to 60.5, and for general science from 70.9 to 77.9. English now makes up 22 per cent of the entire offerings of these schools. Four foreign lan-

guages make up 5½ per cent of the total. English and the social studies together include more than 52 per cent of the total offerings. The science group makes up nearly 13 per cent of the total, a gain of over 2 per cent in the ten years. Mathematics has remained constant with 15 per cent of offerings. There has been a slight decline in the offering in vocational subjects, agriculture, home economics and manual training.
—R.K.W.

Fourth Handbook of the National Honor Society. Cicero, Illinois: Bulletin of the Department of Secondary-School Principals of the National Education Association. May, 1932.

High-school principals and sponsors of chapters of the *National Honor Society* will be interested in these phases of the new handbook: new rituals; methods of evaluating qualities of leadership and service; the selection of new members; descriptions of activities of chapters in rendering service to schools and communities; and suggestions for making local chapters of greater service to members.

Teachers and principals should note the warning concerning a new scheme contained in this handbook. So-called honor societies are apparently being promoted among high school pupils for the profit in the sale of emblems and supplies. Consult the handbook of the *National Honor Society* for authentic information concerning the recognized honor society for high school pupils. —R.K.W.

Teacher Demand and Supply. Washington: Research Bulletin of the National Education Association, 1931. 93 p.

This bulletin is a report of a Committee of the N.E.A. appointed at the meeting in Seattle in 1927. The Committee consists of B. R. Buckingham, chairman, Florence Bernard, W. W. Coxe, Susan M. Dorsey, E. C. Hartwell, J. R. McGaughey, and Frederick L. Whitney. The bulletin outlines a program of investigation and recommends that the study be made a continuing one. Chapter II is a summary of previous investigations of teacher supply and demand. Chapter III is a status study for elementary- and high-school teachers. Chapter IV is a summary of conditions by states. Other chapters treat procedures for securing data and the adequacy with which state departments of education are attempting to control supply of teachers and determine demands. A selected and annotated bibliography of 173 titles is included.

Data presented by the committee show that there is an actual surplus of teachers, and potential teachers who have received certificates from various certificating agencies. The data also show that there is an actual shortage, in most states, of trained teachers.

Recommendations include elimination of many private teacher-training institutions and departments in private colleges, the centralization of state control of teacher training, raising the qualifications for the certification of teachers, centralization and standardization of certificating agencies, and the gathering of adequate data on supply and demand by state departments of education. —R.K.W.

Symonds, P. M. "Diagnosing the Personality of High School Youth." *School* 43:605-606; August 11, 1932.

In this article the author briefly describes the uses and functions of tests to determine the pupil's intelligence, interests, behavior, adjustment, and health. These tests are of vital importance in getting at a real understanding of a particular boy or girl. There is also a great need for studying the qualities of personality possessed by boys and girls who have attained positions of leadership in school affairs. Some progress has been made along this line, but the need for research is urgent.—C.M.P.

Touton, Frank C. "The Rôles of Purpose, Content and Method in the Teaching of Secondary Mathematics." *California Quarterly of Secondary Education* 8:12-22; October, 1932.

Although this article is for mathematics teachers, so much of it is applicable to the science teacher that the abstracter feels impelled to call it to the attention of science teachers. The article lists ten general objectives of secondary education as follows: (1) developing physical fitness; (2) applying fundamental processes to scientific and social phenomena; (3) discover-

ing interests and aptitudes; (4) using native capacities to the maximum; (5) preparing for economic independence or advanced training; (6) participating in diversified æsthetic and recreational activities; (7) evolving high standards of conduct in personal and group life; (8) evaluating the past to determine its contribution to the present; (9) contributing to worthy home life; (10) understanding the significance of larger group relationships in the world today.

The article lists the specific objectives that mathematics make to each of these larger objectives. The use of mathematics in adolescent and adult life are classified under six major heads. —C. M. P.

Briggs, Thomas H. "A Vision of Secondary Education." *Teachers College Record* 34:1-17; October, 1932.

In this address at the Teachers College (Columbia University) Conference on Secondary Education, the author lists the following important facts on which a vision of secondary education may be based: (1) at no time, from the beginning to the present, has there been fundamental thinking that has materially affected secondary education; (2) although there is much vague dissatisfaction today with our secondary education, it is not too much to say that, by and large, there is a stifling satisfaction with tradition; (3) the American people have in education a transcendent faith; (4) this fetish happily reached its zenith coincident with economic prosperity and rapid multiple changes in all forms of modern life; (5) when one considers the diversity of our magnificent country, including Alaska and the far-flung dependencies, it is remarkable that secondary schools are so standardized; (6) advances have been made in secondary education itself as well as with its machinery; (7) the enrollment in secondary schools, as compared with foreign secondary schools, is stupendous; (8) the facts of individual differences, whether caused by inheritance or environment, are better known than provided for by a diversified program; (9) beginning with the century, psychology has been remade; (10) for various reasons, many teachers have lost faith in the efficacy of the subject they profess to teach; (11) secondary pupils understand, learn, retain, and use little of what the curriculum plans; (12) with the rapid development of the number and enrollment of secondary schools we have not been able to recruit and adequately train a body of competent teachers; (13) there is everywhere among the profession, no less than among the public, an expectation of miracles.

The author believes that the new secondary education will be based on a general recognition by the public that it is vitally important. Effective education cannot be divorced from large social aims. The new education will be more comprehensive than the traditional. There will be no contest, as there now is, between the materially utilitarian and the cultural education. The future will bring an extensive program of comprehensive planning. Teachers will be soundly trained for the responsibilities that they are expected to assume.

—C. M. P.

Horne, Herman H. "An Idealistic Philosophy of Education." *The Kadelpian Review* 12:5-15; November, 1932.

Our problems cannot be solved without the aid of science as a means. Nor yet can they be solved by the aid of science alone, according to the author. Philosophy must step in to determine our ends, for science can only furnish the means. Philosophy is defined as one's world-view. An idealistic philosophy of education is one that sees the meaning of education in relationship to a meaningful universe. Some of its leading traits are the following: (1) education is a cosmic process; (2) education is a temporal process; (3) the origin of man is the Personal Factor in the universe, to which his education should consciously relate him; (4) the environment of man is purposeful; (5) the education of man, whose nature is freedom, is through discipline to freedom; (6) the destiny of man being immortality, the education of man is unending, and (7) education is thus the process of perfecting humanity in the image of divinity.

—C. M. P.

Eliassen, R. H. "Classroom Problems of Recent Teaching Graduates." *Educational Research Bulletin* (Ohio State University) 11:370-372; November 9, 1932.

This is the résumé of an investigation involving 602 graduates of Ohio State University: 120 men and 482 women. The classroom problems met by these new teachers were classified as follows (stated in percentage):

Problems	*Men*	*Women*
Stimulation of interest	28	39
Discipline or control of pupils	14	27
Provision for individual differences	14	15
Adjustment of teacher to classroom situations	13	11
Organization of work and materials	13	10
Getting pupils to make preparation	11	10
Presentation of subject matter	8	6
Lack of suitable reference material	8	5
Weak academic background	6	4
Holding interest through period	4	4
Getting pupils to use good English	1	5
Securing coöperation of parents and teachers	5	2
Teaching foreigners	1	2
Hampering of work through heavy outside activities	0	1
Overcoming self-consciousness and sarcasm	0	1
Measurement of achievement	1	0

—C. M. P.

HOLY, T. C. "The Payment of Teachers' Salaries on a Twelve-Month Basis." *Educational Research Bulletin* (Ohio State University) 11: 365-370; November 12, 1932.

The article presents reasons for the payment of teachers' salaries on a twelve-month basis. Such an arrangement would lead to a more equitable distribution of money paid in as taxes for support of education and would also give a correct comparison of teachers' salaries with those of other occupations. Comparisons made on a basis of monthly payments are entirely misleading. —C. M. P.

DAVIS, EMILY. "New Chapters in American History." *Science News Letter* 22: 306-307; November, 1932.

The article describes the researches of Hjalmar R. Holand relating to the Kensington Stone discovered near Kensington, Minnesota, about thirty-five years ago. The stone has the following words engraved upon it: "(We are) 8 Goths (Swedes) and 22 Norwegians on (an) exploration-journey from Vinland over the West (i.e. through the western regions). We had camp by 2 skerries (i.e. by a lake wherein are two place-rocks) one day's journey from this stone we were (out) and fished one day. After we came home (we) found 10 (of our) men red with blood and dead Ave Maria Save (us) from evil."

On the edge of the stone were the following words: "(We) have 10 of our party by the sea to look after our ships (or ship) 14 days-journey from this island Year 1362." Researches seem to confirm Holand's belief that the stone is a record left by a company of Swedes and Norwegians who visited Minnesota in 1362, coming via Hudson Strait and Hudson Bay, then down the Nelson River to Lake Winnepeg, and thence to Minnesota. —C. M. P.

Science Education in General

MEISTER, MORRIS. "Recent Educational Research in Science Teaching." *School Science and Mathematics* 32: 875-889; November, 1932.

The author expertly evaluates and interprets the significance of a considerable number of the most important research contributions of the past few years, assuming the unique viewpoint of a critic of the year 1999. The article deals with a wide variety of problems of method and technique in science teaching from the early grades through the high school. —F. D. C.

DAVIS, IRA C., Chairman. "A Wisconsin Philosophy of Science Teaching." *School Science and Mathematics* 32: 760-764; October, 1932.

The Committee of the State Teachers Association of Wisconsin present a dis-

cussion of their philosophy under these heads: (1) Need for a Philosophy; (2) Wisconsin Program of Education; (3) General Objectives of Science Teaching; (4) Futility of Ranking Objectives; (5) Specific Objectives; (6) Putting the Philosophy into Practice; (7) Measuring Results; and (8) Further Experimentation Needed. Their fourteen specific objectives are: command of factual information; familiarity with laws, principles, and theories; power to distinguish between fact and theory; concept of cause and effect relationships; ability to make observations; habit of basing judgment on fact; ability to formulate workable hypotheses; willingness to change opinion on basis of new evidence; freedom from superstitions; appreciation of the contributions of science to our civilization; appreciation of man's place in the universe; appreciation of possible future developments of science; and possession of interest in science.

—F. D. C.

Miller, L. P. "The Effective Use of Aids in Science Instruction." *The High School Teacher* 8: 352; November, 1932.

The first part of this short article deals with the dangers involved in passive use and careless selection of visual aids. The point of view of the author may be summed up in this quoted sentence. "Visual aids which can be effectively used in science instruction are: (a) those planned and constructed by the pupils themselves, and (b) those produced commercially, for which real need exists."

The most useful part of the article consists of the practical working bibliography which is to be recommended to all science teachers interested in visual aids.

—R. K. W.

Van de Water, Marjorie. "Are You Still Superstitious?" *Science News Letter* 22: 274-275; October 29, 1932.

This article presents a study carried out by Dr. A. O. Bowden, President of the New Mexico State Teachers College, among the parents of elementary pupils in fourteen states. He found that a high percentage of teachers are superstitious, although the percentage is not as high as among non-teachers. Girls are more superstitious than boys. The article lists many of the common superstitions.

—C. M. P.

Report of the Committee on the Teaching Load for Chemistry Teachers. *Journal of Chemical Education* 9: 2111-2126; December, 1932.

This is a report made to the Division of Chemical Education, American Chemical Society, Denver, Colorado, August 24, 1932. Data relating to salaries and teaching load are presented. The report concludes that there is considerable evidence to show that teachers of chemistry in many institutions are carrying more than their share of the teaching load. The Committee also recommends that one clock hour of laboratory work should be considered equal to one clock hour of lecture or recitation. The Division of Chemical Education has twice gone on record in favor of this method of computing teaching load, rather than the common practice of counting two laboratory hours the equivalent of one hour of lecture or recitation. —C. M. P.

Anonymous. "The Story of the Map." *National Geographic Magazine* 62: 759-774; December, 1932.

This article relates the interesting history of map making. Several photographs of famous early maps are included. Among these are: Captain John Smith's Map of Virginia (1612); an ancient clay map found at Nuzi, in Iraq; a 16th century map of the Pacific; Marquette's map of the Great Lakes region (1673); and the famous Waldseemuller world map of 1507, reputed the first to carry the name of "America." Accompanying the article is a new Map of the World by the National Geographic Society containing 4831 names. In comparison with their 1922 World Map, this new map has added 521 new place names and the spelling of 1226 place names has been changed. —C. M. P.

Science in Elementary Grades

PALMER, E. LAURENCE. "Teachers Number." *Cornell Rural School Leaflet* 26: 1-96; September, 1932.

The leaflet presents supplementary material to be used in connection with the New York State elementary science syllabus. The leaflet presents information relating to space studies, behavior studies, studies of man in his environment, and habits of fish in New York State waters. Especial attention is paid to energy studies. A list of useful books in elementary science and nature study which have appeared in 1931-32 is included. —C. M. P.

PALMER, E. LAURENCE. "Poisons, Diseases and Medicine." *Cornell Rural School Leaflet* 26: 3-47; November, 1932.

This illustrated leaflet describes the plants and animals, common to New York state, that are either poisonous to man or act as carriers of disease. The control of disease poisons is discussed at length.

—C. M. P.

Science in Grades Seven, Eight, and Nine

MITCHELL, GUY ELLIOT. "Big Springs." *Scientific American* 147:284-285; November, 1932.

This illustrated article describes some of the largest of 11,000 large springs in the United States. Silver Spring Florida is the largest limestone spring. It could supply New York City with all the water it uses. Giant Springs near Great Falls Montana is the largest sandstone spring. Thousand Springs in Idaho and Mammoth Spring in Arkansas are other large springs.

—C. M. P.

STEVENS, ALBERT W. "Photographing the Eclipse of 1932 from the Air." *National Geographic Magazine* 62:581-596; November, 1932.

This article describes the total eclipse of the sun on August 31, 1932, as viewed from a height of five miles above the surface of the earth. There are 18 illustrations.

—C. M. P.

MCNALLY, PAUL A. "Observing a Total Eclipse of the Sun." *National Geographic Magazine* 62:598-605; November, 1932.

An article describing the years of work for science in preparing for the few seconds of permissible observation of "nature's most magnificent spectacle." Six illustrations are included. —C. M. P.

Science in Senior High School

MAYHALL, MILDRED P. and MCSPADDEN, W. W. "Life of the Past—A Unit for a Course of Study in High School Biology." *School Science and Mathematics* 32: 711-720; October, 1932.

A presentation of a unit on paleontologic study included in the last half of the ninth-grade biology course in the Austin, Texas, schools. An outline of the unit complete with references is followed by considerable explanatory and source material for the teacher. The last part of the article is devoted to a description of methods, materials, and techniques employed in presenting the unit. —F. D. C.

LILLINGSTON, CLAUDE. "Pioneers in Medicine—Marie Curie." *Hygeia* 10:1004-1007; November, 1932.

This article summarizes the outstanding achievements in the life work of Mme. Marie Curie, such as those relating to her early scientific training in the laboratories of her father, a brilliant Polish scientist; the untiring efforts in scientific research of Mme. Curie and her husband, Pierre Curie; the announcement in 1898 of the existence of polonium and radium, two radio-elements in pitchblende; the demonstration in 1902 "that the radioactivity of radium is a million times greater than that of uranium and that this amazing property of radium depends on the slow destruction of its atoms;" the award of the Davy Medal of the British Royal Society; the division of the Nobel prize for physics between the Curies and Henri Becquerel; the award of the Nobel prize for chemistry to Mme. Curie for her work on

radioactivity; her appointment as head of the Radium Institute in Paris; and as further recognition of her work, the election as honorary president of the Third International Congress on Radiology.

The benefits of radium in the treatment of superficial forms of cancer are due to the genius and achievements of Mme. Curie, a modest unassuming, tireless worker in the field of science. —F. G. B.

BLAIR, W. REID. "The Medical Care of Animals in the Zoo." *Scientific Monthly* 35:454-457; November, 1932.

Animals in a zoo require medical care as well as other animals. The article describes interesting operations performed upon such animals as bears, rhinoceroses, lions, and tigers. —C. M. P.

EBEY, CLARENCE. "New Plant Wizard Rivals the Great Burbank." *Popular Science Monthly* 121:44-45; 106; December, 1932.

This illustrated article describes the work of William H. Henderson in improving plants. Henderson, who formerly worked with Burbank, has had remarkable success in improving such plants as the Muscat grape, Golden Bantam sweetcorn, the chard, gladiolus, zinnia, daisy, and amaryllis. —C. M. P.

CHAMBERLAIN, CHARLES JOSEPH. "The Age and Size of Plants." *The Scientific Monthly* 35:481-491; December, 1932.

Plants live to a much greater age than do animals. The oldest of all living things are trees. The Sequoias of California are among the largest and oldest trees in the world. The General Sherman is the largest of the Sequois from the standpoint of lumber; it would make 50,000 feet of lumber. The Hart Tree is the tallest, 277 feet high, and the General Grant has the greatest diameter, namely, 33 feet. These Sequoia trees, however, are surpassed by the Big Tree of Tule, about 250 miles south of the old city of Mexico. This tree is 50 feet in diameter, not measured at a flaring base, but where it begins to branch. It is a Montezuma Cypress. It is thought by botanists to be at least 5000 years old and may be as old as 7000 years according to one authority of plant anatomy. —C. M. P.

HEGNER, ROBERT, "Your International Menagerie." *Scientific American* 147: 346-348; December, 1932.

Every individual is comparable to a menagerie. The human body may appropriately be compared to a zoölogical garden closed for the winter. In both cases the animals are there but one can't see them. In this article the author describes the protozoa of man which use the human body as a residence, a food supply, and a common carrier. The author groups protozoa into two classes: the intestinal protozoa which inhabit the digestive tract and the blood-inhabiting protozoa of the blood stream. At least 25 species of protozoa live in the human body. A majority of these are not destructive to man.

—C. M. P.

BEEBE, WILLIAM. "A Wonderer Under Sea." *National Geographic Magazine* 62:740-758; December, 1932.

The author describes his explorations in Neptune's hidden world of vivid color. This wonderer under the sea takes you with him on a hurried trip around the world extending from Alaska to Almost Island, near Nonsuch, just off the coast of Bermuda. In this vast world of water there exists a plant kingdom and an animal kingdom that seems strange indeed to those of us who are accustomed to land plants and animals. There are twenty-one photographs including eight which are colored. —C. M. P.

New publications

Powers, Samuel Ralph, and Brown, H. Emmett. *Workbook in Physics.* Boston: Allyn and Bacon, 1932. 294 p. $0.80.

This workbook includes 100 exercises designed "to aid students in learning high school physics." They are arranged to develop certain topics which are considered important by the authors. The three types of activities most common are completing uncompleted declarative sentences; checking items to show recognition of important concepts; and answering significant queries concerning some diagramatic illustrations. The exercises follow generally the order of the textbook *First Principles in Physics* by Fuller, Brownlee, and Baker, but according to the authors, may be used with any textbook. Page references to five textbooks are given. Figures included number one hundred fifty-three.

—A. W. H.

Glenn, Earl R. and Gruenberg, Benjamin C. *Instructional Tests in General Science.* Yonkers-on-Hudson (New York): World Book Company, 1932. 92 p. $0.36.

These tests are based on a detailed analysis of the most generally used high-school textbooks in general science. In this analysis the items were classified as follows: (1) essential facts, (2) laws and generalizations, (3) explanations of natural phenomena and practical devices, (4) numerical problems, (5) biography, (6) technical vocabulary, and (7) conventional symbols and diagrams. The test items were then tried out in many schools and again revised.

The following types of questions are used: (1) completion type, (2) multiple-choice, (3) matching questions, (4) true-false, (5) brief-answer, and (6) modified true-false.

Three uses have been developed for the tests: (1) as achievement tests near the end of instruction on a topic; (2) as "open book" tests during supervised study periods; and (3) as assignments for work to be done outside of class periods.

The tests cover thirty-five topics, including 1575 questions and 99 illustrations. Norms have been established for most of the units. A teacher's Manual and Key accompany the tests. All teachers of general science will find these tests most helpful.

—C. M. P.

Hunter, George W. and Whitman, Walter G. *Workbook for Problems in General Science.* New York: American Book Company, 1932. 336 p. $0.60.

This is a workbook to accompany the authors' general science text, *Problems in General Science.* Cross references to the text are many and detailed; many directions in the workbook consisting of page references to suggested exercises in the text. For this reason the workbook is not suitable for use with other texts.

The material is organized into major instructional units and each of these into problems. Title pages for units are left blank in order that pupils may exercise ingenuity in appropriate decoration and outlining. Following the title page is a guide sheet providing space for an outline of material secured by reference to the text. The workbook exercises follow. At the end of each unit are printed forms

for recording answers to the tests which are printed in the text and not in the workbook. Space is left here for a very brief review outline. Following is a space in which the pupil is to record a biographical sketch of some man of science. The next page provides blank space in which the pupil may record any original ideas or queries of his own. The two final pages for the unit provide blank space for a record of current science happenings which may be in the form of notes, diagrams, pictures or clippings.

Ample opportunity is provided for creative work and free expression on the part of pupils. The text and workbook together furnish a considerable body of material and suggestion for superior pupils. Suggestions for many worth while demonstrations are provided. Diagrams are provided in the text of the workbook so that the pupil needs to do relatively little drawing.

The testing scheme may be awkward in administration in that the tests are printed in the text and marked on separate sheets in the workbook. Space for writing answers to achievement tests seems rather too small. Achievement tests are not objective. The tabular marking in the workbook has the advantage of making the scoring of tests very simple for the teacher.

The workbook is recommended to those teachers using *Problems in General Science*, and to those using other texts, as a source of many and varied useful exercises.

—R. K. W.

Russell, Bertrand. *Education and the Modern World.* New York: W. W. Norton and Co., 1932. 240 p. $2.50.

One of the chief values claimed for the teaching of science has been that it develops ability to use a scientific method of thinking. It has been rather tacitly assumed that practice of this method, either directly through the solving of simple problems or vicariously through the study of how others have solved problems, would give facility in using the procedures of critical thinking in problems of everyday living. If such transfer takes place it is probably necessary that the learner be made aware of the similarities existing between the two sets of data. It is the reviewer's belief that the teacher of science has some measure of responsibility in emphasizing this point of view.

Russell's analysis of the relation between systems of education and the problems of the modern world abounds with examples of such relationships. The reading of this book should form a part of the liberal education of the teacher of any subject, but it has particular significance for teachers of science and of history. Although dealing specifically with English schools it applies equally well, except in a few instances, to conditions in America. The reviewer considers the chapters on *Patriotism in Education* and *Propaganda in Education* of particular value and interest.

The style is delightfully clear and does not require a technical knowledge of the vocabulary of philosophy for its understanding. Its logic, at most points, is irresistible.

—O. E. Underhill

Hawks, Lena James. *Certain Relationships Between Scholarship in High School and in College.* Baltimore: The Johns Hopkins Press, 1931. 58 p. $1.15.

This study is No. 15 in the Johns Hopkins University *Studies in Education*. The investigator's purposes were to determine the subjects or combination of subjects taken in high school which form the most effective basis for predicting scholastic success in college and to determine if college success may be predicted from the last three years' work in high school as readily as from the four-year record.

Data were secured from Johns Hopkins, Vanderbilt, and Gettysburg College and from the high-school records of students entering these institutions in 1924, 1925, and 1926. Teachers' marks given in high school and college form the basis of the study.

The conclusions were as follows:

". . . any college registrar, by painstaking work with records extending over a period of years, can locate students who would prove unsatisfactory in his own institution. . . ."

"It appeared from the records that in none of the institutions studied was the certificating grade (for college entrance) operative."

"A higher degree of uniformity in representing student achievement at the high-school level is much to be desired."

Marks used in the study are percentage marks. Many critics will be inclined to question the value of studies based upon this system of markings. Statistical juggling of such marks to arrive at hypothetical "passing marks" other than those reported and used by the schools in the study may be questioned by some critics.

The answers to the original questions raised in the study were that academic studies formed better basis for prediction than non-academic studies, and that four years of high-school work gave a slightly better basis for prediction than the last three years. —R. K. W.

THORNDIKE, EDWARD L. *The Fundamentals of Learning*. New York: Bureau of Publications, Teachers College, Columbia University, 1932. 638 p. $6.50.

This volume is a report and interpretation of experimental studies in the psychology of learning carried on by the author and his associates through a period of some three years. In the experimentation, answers were sought to five major questions each of which may be seen as related to the connectionist's theories of learnings. These major questions were: (1) "What does the mere repetition of a situation, in and of itself, do to the mind?", (2) "What does the mere repetition of a connection, in and of itself, do?" and "What does the repetition of a sequence whose two terms 'belong' together do?", (3) "What elementary and general facts explain the influence which rewards and punishments have upon the learning of animals and man?" "Does satisfaction strengthen a mental connection?", (4) "How does the satisfying (effect) add strength to the connection to which it is attached?", and (5) "How does the unfavorable effect of punishment come about?" Some other questions rated by the author as of less importance were also investigated.

The detail in which the work is reported makes it possible for the critical reader to review the methods of experimentation, the data, and the conclusions.

The conclusions from these many experiments may not be stated here. The student of education will be particularly interested in the conclusions respecting readiness, identifiability, and availability. These conclusions are summarized as follows:

"In every act of learning the readiness of the connections concerned is a conditioning factor; and in the learning of interests, attitudes, and motives, readinesses are a large fraction of what we learn." (p. 338)

"Other things being equal, connections are easy to form in proportion as the situation is identifiable, distinguishable from others, such that the neurones can grasp and hold and do something with or to it." (p. 343)

"Other things being equal, connections are easy to form in proportion as the response is available, summonable, such that the person can have it or make it at will." (p. 345)

In his last chapter, "Adverse Evidence and Arguments," the author gives attention to the conclusions of other investigators that have been cited as being in conflict with his own. —S. R. P.

KILPATRICK, WILLIAM HEARD. *Education and the Social Crisis*. New York: Horace Liveright, Inc., 1932. 90 p. $1.25.

This is the fourth in the Kappa Delta Pi Lecture Series devoted to discussions of the broad meaning of education. In this volume, Kilpatrick analyzes the social problems of the hour and proposes an educational program that looks toward their ultimate solutions.

As the author sees it our present economic machinery has broken down; our old rugged individualism or individual freedom is a thing of the past; and our economic philosophy, based on the profit motive, is responsible for crime, racketeering, corruption in government, politics and business. Indeed he asserts that the profit motive so dominates every phase of our life that many erroneously assume it is an instinct, fixed in human nature. To remedy the situation we must have social planning on a broad scale. This social planning must be a coöperative effort and the changes to be inaugurated must be evolutionary rather than revolutionary. A new

type of adult education and vocational training will result and the new school will have a new type curriculum. The school will devote itself largely to the pressing social problems of the day. —C. M. P.

MORGAN, THOMAS HUNT. *The Scientific Basis of Evolution*. New York: W. W. Norton and Company, 1932. 286 p. $3.50.

This book is based upon the Messenger lectures, given at Cornell University in 1931. It is the work of T. H. Morgan, formerly Professor of Experimental Zoölogy at Columbia University and, since 1928, Professor of Biology at the California Institute of Technology.

Morgan brings his many years of experience with heredity and mutations to bear upon the problem of evolution. He says that the study of evolutionary problems has been sufficiently refined to "rest our case for its acceptance on the same scientific procedure that has led to the great advances in chemistry and physics."

In the course of the discussion many subjects are reviewed and extended, including the relationship of DeVries' mutation theory to modern concepts of evolution, the chromosomes and variation, the chromosomes and the cell-plasm, Mendelism and evolution, the determination of sex, variation and artificial selection, adaptation, the genes as the units of inheritance, sexual selection and hormones, embryonic development and the recapitulation theory, acquired characteristics, social evolution, and philosophical pronouncements concerning evolution.

The discussion of adaptation and natural selection is one of the most interesting treatments. Morgan states that "Biologists find no support for the idea that an organism responds adaptively (purposefully?) to new environments." With regard to acquired characters he tells us that "It is not as generally known as it should be that the new work in genetics has struck a fatal blow to the old doctrine of the inheritance of acquired characters." And with reference to metaphysical explanations of evolution by philosophers, Morgan says that the time has passed when everyone can speculate about evolution "without respect to the evidence at hand, and more particularly without any regard to the kind of evidence on which an opinion can safely rest."

It may be said that this is a very interesting book to the biologist. In the first place it includes many items of information and results of modern research that are absent in other general treatments of the subject. Secondly, Morgan gives us clear-cut and definite interpretations of various points at issue, without any attempt at evasion.

—F. L. FITZPATRICK

MATHER, KIRTLEY F. *Sons of the Earth*. New York: W. W. Norton and Co., 1930. 263 p. $3.50.

In his usual brilliant and interesting manner, Kirtley Mather, Professor of Geology at Harvard University, has written an ancient history from the geologist's point of view. The first chapter gives a clear account of the language in which "Mother Earth's Diary" is written, and explains how the geologist obtains and interprets his data. The second and third chapters trace "The Stream of Life" through the "Family Tree of Higher Vertebrates" to the advent of man. The next three chapters deal with the various "apeman" remains and with the early cultures as deduced from the artifacts of the Pleistocene. The remaining two chapters "The Heritage from Mother Earth" and "The Outlook for the Future" serve as an interpretive summary.

This is a most excellent treatment for the general reader or teacher who wishes a meaningful survey of the place of man in the evolutionary scheme. The illustrations are happily chosen, particularly those which deal with comparative anatomy. The book forms a fitting sequel to *Old Mother Earth* by the same author.

—O. E. UNDERHILL

ROWAN, WILLIAM. *The Riddle of Migration*. Baltimore: Williams and Wilkins Co., 1931. 145 p. $2.00.

The following quotation from the jacket of the volume suggests that it may prove intriguing. "The structure of the atom, the birth of a child, relativity, the tunnelling of a mountain, the broadcasting of messages through the ether from continent to con-

tinent, such things we understand, or think we do. . . . But the annual, the precise return of migrating wild fowl?" And the suggestion is not belied. The short introduction makes clear, by an interesting example, that the naturalist cannot find the answer to many of his problems through field observations alone. The problems of biology are now so complex that the special knowledge of the chemist and physicist must join with that of the physiologist and anatomist in order to attack them with any measure of success.

This study emphasizes the technical biologist's contribution to the problem, referring to the various field aspects only as necessity arises, such observation by ornithologists having been fully set forth in other works. After indicating the scope of the problem and presenting various theories with evidence pro and con, a series of experiments, as interesting as they are ingenious, is described, which tends to show that changes in the gonads brought about by amount of exercise, which is in turn controlled by length of daylight, is the factor that stimulates the migratory impulse. This is the one factor which changes regularly with the seasons and would account for the regularity with which birds migrate regardless of the temperature or state of food supply. Similar experiments, however, by other investigators have led them to reach almost opposite conclusions as to the relation of light and exercise to changes in the gonads (Bissonnette).

The discussion leads to such widely separated fields as structural adaptation, paleontology, glaciation, inheritance of acquired characteristics, and action of endocrines. Writers of textbooks and readers for elementary-school children who deal with the subject of migration would do well to study this book and high school biology teachers should find in it material that would greatly help to increase interest in a subject that is usually barely touched upon, or explained in a much more simple manner than the facts seem to warrant. Also the general discussion at each point furnishes much interesting illustrative material in connection with many of the larger principles of biology.

—O. E. UNDERHILL

EMERSON, HAVEN. *Alcohol and Man*. New York: The Macmillan Company, 1932. 451 p. $3.50.

This volume is the answer of the medical sciences to the muddled thinking, the emotional floundering, the political propaganda of the laity, in determining a national policy to deal with the liquor traffic. It treats of the effects of alcohol on man in health and disease. In the preface the authors state that they "have been scrupulous in avoiding 'pro' and 'anti', 'wet' or 'dry' implications" and that "in no instance have the authors participating in this volume been aided financially, or supported in any way by the advocates or opponents of Federal Prohibition or the liquor trade."

The book represents the results of scientific study of the real effects of alcohol on man by men who are better qualified than anyone else to make this determination. Many authors make a contribution to this study. There are presented data relating to the effect of alcohol upon simple unicellular organisms; upon the germ cell; the actions of alcohol on the normal experimental animal and upon man, in moderate, toxic and therapeutic doses; and the damage done by alcohol to man's resistance to disease and to his body tissues. There are excellent chapters on alcohol as a social problem, the effects of alcohol upon the spirit and conduct of man, his personality and his reactions to the material and social environment.

The book is divided into six parts as follows: (1) The Effects of Alcohol on Human Functions; (2) The Effects of Alcohol on the Cell and in Heredity; (3) Alcohol as a Poison and as a Medicine; (4) Alcohol and Body Resistance and Pathology; (5) The Effect of Alcohol on Man's Conduct and Mentality; (6) Alcohol and Longevity, Mortality, and Morbidity.

It contains the most authentic, unbiased and unprejudiced information that has yet been presented on a problem that has been and is now so much in the forefront of public discussion. Throughout the volume, facts and opinions are supported by facts to which references are available. The reviewer predicts that it will be one of the most widely quoted books that have ap-

peared in recent years and that some of it will form a part of school textbooks in physiology, health, and biology, either as the basis for what the textbook says regarding alcohol or being quoted verbatim. It is regrettable that his book has not been available during the past few years when education might have prevented the present muddled situation. The authors are convinced that education (not propaganda) must precede legislation before wise action can be taken in matters where social and personal habits are concerned.

—C. M. P.

GOODE, J. PAUL. *Goode's School Atlas.* Chicago: Rand McNally and Company, 1932. 287 p. $4.00.

This revised and enlarged Atlas is really an exceptional book. There are 174 pages of maps, representing practically every phase of geographical study. The maps are up-to-date, being based on recent governmental statistics. Students of all levels from the elementary to the graduate schools, will find here the geographical information so often desired. The author is the late J. Paul Goode, for many years Professor of Geography at the University of Chicago and long known as an authority on map construction.

General science and physical geography teachers will find many excellent maps relating to physical relief, winds, temperature, air pressure, rainfall, and climate.

All foreign city names are spelled in their local official forms. Over 30,000 geographical names are included in the index with the latitude and longitude for each, the country or region in which it is located, and the page reference to the largest-scale map reference on which it occurs. A pronouncing guide is provided for each name.

—C. M. P.

THOMPSON, SIR J. ARTHUR. *Riddles of Science.* New York: Horace Liveright, Inc., 1932. 387 p. $3.50.

A series of short essays varying from a few pages to ten or fifteen in length and covering an extremely wide range of subjects. Although there is little attempt at organization, in many cases the central theme of one essay is suggested in the one preceding it, so that one can read along steadily without too abrupt shift of the thought. The book is divided, according to the table of contents, into four parts and an epilogue, although the reviewer finds it difficult to determine the basis of this separation. The fourth section and the epilogue become quite philosophical and in the reviewer's opinion somewhat mystical.

Some of the essays which seem particularly interesting are "What is the Meaning of Color?", which develops this subject from a rather unusual biological point of view; "In How Many Different Ways May an Animal Appear Green"; "Why Does Our Hair Turn Grey?"; and "Cuckoo Puzzles." A few more titles, selected at random will show the nature of the first three sections: "What is Protoplasm?"; "What are Chromosomes?"; "Why Do We Fall Asleep?"; "Why Do We Laugh?"; "What are Enzymes?"; "The Cat's Nine Lives"; "Walking in a Circle"; "How Is the Earth Kept so Clean?"; "Is Telepathy a Fact?" The fourth section deals with purposiveness in evolution, and the "Epilogue" with such topics as, "The Orderliness of the World"; "The Beauty of Living Creatures"; "The Progress of the World"; "Ideals in Nature"; "The Awesomeness of Nature."

The book as a whole is extremely interesting and thought-provoking, and should have its place beside the other popular works of this author in the school library. —O. E. UNDERHILL

SCOTT, WILLIAM B. *An Introduction to Geology,* New York: The Macmillan Company. Volume I, *Physical Geology,* 1932, 604 p. $3.50. Volume II, *Historical Geology,* 1932. 485 p. $3.00.

The story of the earth has been made much more complete by the researches which have delved deeply into the earth's records within the last twenty-five years. This two-volume series of books brings out much of the new material in an interesting and simple presentation. The books are of elementary-college grade and offer splendid material for a course in teacher-training institutions. Volume I, in particular, supplies a very desirable background for teachers of geography and general science. The books are well illustrated and substantially bound.

—W.G.W.

SCHNEIDER, W. A. and HAM, L. B. *Experimental Physics for College*. New York: The Macmillan Company, 1932. 259 p. $2.25.

The book deals with something more than laboratory directions, for there is textual material covering the experiments. It is for the elementary-college student and has been planned for the class to keep "even front" students working in pairs. The experiments require about two hours, but may be shortened by taking fewer readings than are suggested. Questions and problems are given at the close of each chapter. These questions can be answered only by those who have mastered the theory taken up in the chapter.

—W.G.W.

SMYTHE, W. R. and MICHALLS, W. C. *Advanced Electric Measurements*, New York: D. Van Nostrand Company, Inc., 1930. 240 p. $3.00.

Material suitable for training seniors in electrical engineering in the use of electric instruments and methods of measurement, to give a foundation for research, testing and development work is provided in this text. Topics include: graphic representation; precision of measurement; measurement of resistance; current; potential difference; quantity of electricity; vacuum tubes; A.C. instruments; A.C. bridges; electrical thermometry; radiation; and electro-chemical measurement.

—W.G.W.

CHASE, CARL T. *A History of Experimental Physics*. New York: D. Van Nostrand Company, Inc., 1932. 193 p. $2.25.

Students will obtain from this volume a perspective of the field of experimental physics from the present time back to the very beginnings. The difficulty and obstacles of the early experimenters, together with the absence of previous observations to give them a start, reveal the epoch-making character of their work. The book includes discussions of the beginning of physics: Galileo's wave theory of light; atoms and molecules; Faraday; Hertz; and Maxwell; X-rays; radio activity; quantum theory; Bohr atom; relativity; Michelson and velocity of light; electron; corpuscular nature of radiation; wave nature of the electron; wave mechanics; the new atom. At the close, a chronological table of sixty-nine eminent physicists is included. —W.G.W.

NEWMAN, HENRY. *Lives in the Making*. New York: D. Appleton and Company, 1932. 370 p. $2.25.

Every teacher should read "Lives in the Making." It will help one to meet many of the trying problems of school life. It discusses the "aims and methods for the education of young people in ethics and character building." The main topics are: "What Home and Community Can Do"; "Where Psychology Can Help"; "What Schools Can Do." "Among the chapter titles are: "Why Educate"; "Mental Hygiene Prescribes"; "Individual Differences"; "Learning by Doing"; "Natural Sciences"; and "Mathematics."

—W.G.W.

GLASSTONE, SAMUEL. *Recent Discoveries in Physical Chemistry*. Philadelphia: P. Blakiston's Son and Company, Inc., 1931. 470 p. $3.50.

This book records the new viewpoints given in extensive periodical literature that have not yet been incorporated in the ordinary texts. The purpose is to supply information about modern developments in physical chemistry to those chemists who do not have time to cull the literature and to make this new material more easily available to university students. The subjects treated are: "Electronic Theory of Valency"; "The Parachor"; "Dipole Moments"; "Molecular Spectra"; "Homogeneous Gas Reactions"; "Photochemical Reactions"; "Properties of Surfaces"; "Heterogeneous Catalysis"; "Solubility"; "Strong Electrolytes"; "Acid-Base Catalysis." —W.G.W.

FISH, FLOYD H. *Quantitative Analysis*. Philadelphia: P. Blakiston's Son and Company, Inc., 1931. 120 p. $1.25.

This is a series of lectures and experiments covering the use of the balance, indicators, standard solutions, and various determinations. The work is divided into two parts: (1) for engineers and ap-

plied-science students, (2) for agricultural or home economic students. —W.G.W.

COBLE, MARY F. and LIFE, CORA S. *Introduction to Ornithological Nomenclature.* Los Angeles: Botany Office, University of Southern California, 1932. 91 p. $1.00.

Many bird lovers understand little of the formal titles of birds. When they look up the *Calaveras* Warbler and discover that his scientific name is *Helminthophila rubricapillus gutturalis* and that the name translated means a "worm-lover with a red crown and a conspicuous throat," their interest and enjoyment is greatly increased. This little volume not only gives this type of information, but gives both the Latin and English pronunciations. Birds native to the West and migratory visitors are included.

—W.G.W.

HAUB, HATTIE, D. F. *How to Teach Secondary Chemistry.* San Francisco: Harr Wagner Publishing Company, 1929. 290 p.

An account of a high-school teacher's method of teaching chemistry which has proved to be successful in producing students who "show remarkable interest in chemistry" when they reach college and who have excellent preparation for their college chemistry is given in this publication. There are chapters on the laboratory, the demonstration room, the supply room, and written work, including experiments and tests. There are some helpful suggestions in this book, but today one rather expects suggestions about teaching the electron theory and its broad applications to chemical reactions. The entire omission of any reference to this theory greatly reduces the usefulness of the book.

—W.G.W.

CARR, WILLIAM G. and WAAGE, JOHN. *The Lesson Assignment.* Stanford University, California: Stanford University Press, 1931. 98 p. $1.50.

This book offers practical help to teachers who are interested in making the lesson assignment function as an integral part of the teaching procedure. The author discusses (1) the significance of the assignment in learning and teaching, (2) current practices in making and doing the assignment as indicated by analysis and interpretation of studies which have been made in the field, and (3) thirteen principles which will serve as guides in the making and evaluating of assignments.

An annotated bibliography of eighty-six selected references includes books considering the assignment in general terms and books and articles considering the method of teaching individual subjects which directly emphasize methods of making lesson assignments. —F. G. B.

WOODRUFF, L. L. *Animal Biology.* New York: The Macmillan Company, 1932. 513 p. $3.50.

The book is an adaptation of *Foundations of Biology* by the same author. The fundamental plan of both volumes is the same. Certain sections relating to plants have not been included in the new book. In their place, materials are given relating to representative forms in the chief animal phyla. New illustrations and added materials are included to give an enriched understanding of important principles of biology. The book is intended for use with college classes in animal biology and general zoölogy in which plants and their relation to animals are emphasized incidentally.

Dr. G. A. Baitsell, Yale University, has written a *Manual of Animal Biology* to accompany the book. —F. G. B.

CONN, H. W. *Bacteria, Yeasts, and Molds in the Home.* Boston: Ginn and Company, 1932. 320 p. $1.60.

This is the third edition of a valuable book relating to bacteria, yeasts, and molds. It is intended for use by students of home economics and by those engaged in household activities. In this new edition the content has been brought up-to-date by Harold J. Conn, soil bacteriologist in the New York Agricultural Station. The important changes pertain to sections on refrigeration, canning, and the distribution of diseases. A section giving historical background material of the subject has been added. Directions for suggested experiments for laboratory work are given in the appendix. —F. G. B.

JACKSON, DUGALD C., JR. and JONES, RALPH C. *The Scientific Age.* New York: John Wiley and Sons, 1930. 353 p. $2.00.

This is an extremely happy selection of essays, biographical sketches, informal expositions and editorials, taken from the writings of the leading scientists and philosophers. At a college graduation last June the valedictorian addressed his classmates as men who were about to go out into a world which had no need for them. This book indicates the unlimited possibilities in the field of technology, and makes clear that many problems are waiting for the man with the necessary energy, intelligence, and specialized knowledge to solve them.

Although designed primarily as reading matter for English or orientation classes in schools of technology it is suitable for use with any group of students interested in the modern world and should prove fascinating to the general reader.

As one glances through the table of contents many names familiar to the science teacher appear, such as Slosson, Pupin, Caldwell, DeKruif, Luckiesh, Wiggam, and Wells. But in addition are a number of essays, not usually included in such a collection, by men such as Joseph Husband, Maurice Holland, Ray Stannard Baker (David Grayson), William McFee, Claude Bragdon, Raymond B. Fosdick, Stuart Chase, Dean Inge, Bertrand Russell and Ernest Dimmet, which are stimulating in the extreme. Such essays as "The Axe Helve," and "The Pattern-Makers," paint a picture of craftsmanship and the joy of the individual in a good job well done which is particularly appropriate at this time. The reviewer considers this one of the most inspiring books that could be placed in the hands of young people who have the slightest leanings toward science, and believes that it will prove interesting reading to anyone.

—O. E. UNDERHILL

Report of the New York State Health Commission to His Excellency, the Honorable Franklin D. Roosevelt, Governor of the State of New York. *Public Health in New York State.* Albany: State of New York, Department of Health, 1932. 504 p.

This report comes from the "informal and unofficial" State Health Commission appointed by the Governor to study and report upon the administrative and legislative aspects of public health in New York State. It "deals largely with the reorganization and improvement of local health machinery." The report reviews first the character of the State and local health organizations from the standpoint of form of organization, service, and personnel. This is followed by an analysis and appraisal, with accompanying recommendations, of features suggestive of the major responsibilities of the State in matters of health. There are chapters on "Control of Tuberculosis," "Social Hygiene," "Maternal and Infant Hygiene," "School Hygiene," "Care and Rehabilitation of Crippled Children," "Dental Hygiene," "Mental Hygiene," Industrial Hygiene," "Cancer," "Communicable Disease Control," "Public Health Laboratory Service," "Sanitation and Public Health Education." Each chapter is an analysis of the work of the State followed by a body of recommendations.

For the citizens of the State it is highly informative for it reveals the nature of the work the State is doing to maintain the health of its citizens and the nature of the problems associated with such work.

—S. R. P.

News and announcements

PROGRAM OF THE SIXTH ANNUAL MEETING OF THE NATIONAL ASSOCIATION FOR RESEARCH IN SCIENCE TEACHING

Minneapolis, Minnesota
February 26, 27, 28, 1933

EXECUTIVE COMMITTEE

FRANCIS D. CURTIS, *President*
EDWARD E. WILDMAN, *Vice-President*
S. RALPH POWERS, *Secretary-Treasurer*
ELLIOT R. DOWNING
JOHN HOLLINGER

DINNER MEETING

Sunday Evening, February 26, 1933, 6:30 P.M.
(For Members Only)

Curtis Hotel, Dining Room "A"

1. Business Meeting.
2. Topic for discussion:

   Practical Means of Affording Classroom Training in the Scientific Method and in Building Functional Understandings of the Scientific Attitudes.

Monday, February 27, 1933, 9:30 P.M.
(Open Meeting)
Curtis Hotel

DR. FRANCIS D. CURTIS, Presiding

1. *The General Education Board Survey of Science Teaching.*
   R. J. Havighurst, Ohio State University.
2. *The Survey of Science Conducted by the Office of Education.*
   Wilbur L. Beauchamp, University of Chicago.
3. *A Measurement Program in Junior College Science.*
   Palmer O. Johnson, University of Minnesota.
4. *What Are the Sources of The Teachers of Science in the Accredited Schools of the North Central Association?*
   Francis D. Curtis, University of Michigan.
5. *A Type of Test Exercise Designed for Measurement and Analysis of Pupil Comprehension in Science.*
   J. E. Kirkpatrick, University of Iowa.

Tuesday, February 28, 1933, 9:30 P.M.
(For Members Only)
Curtis Hotel

DR. FRANCIS D. CURTIS, *Presiding*

1. Report of the Associations' Committee on Teacher Training:
   (a) *Professional Subject Matter.*
   A. W. Hurd (Chairman), Columbia University.
   (b) *Professional Courses in College Departments of Education.*
   E. Laurence Palmer, Cornell University.
   (c) *Legal Requirements for Science Teachers.*
   C. M. Pruitt, University of Alabama.
2. Round Table Discussion of Future Plans and Policies of the Association.

PROGRAM OF THE MEETING OF THE NATIONAL COUNCIL OF SUPERVISORS OF ELEMENTARY SCIENCE

Minneapolis, Minnesota
February 25, 1933
Curtis Hotel—The Solarium

President, Lois Meier Shoemaker,
State Teachers College, Trenton, N.J.

Vice-President, R. F. Lund,
Hartford, Connecticut.

Secretary-Treasurer, W. W. McSpadden,
Supervisor of Sciences, Austin, Texas.

MORNING SESSION, 9:30 O'CLOCK

9:30 *Science in the Elementary Grades.*
Fay Rogers, Tuttle School, Minneapolis, Minn.

10:00 *Science in the Intermediate Grades.*
Theodora L. Agather, Howe School, Minneapolis, Minn.

10:30 *The Place of Science in the Elementary School.*
Gerald S. Craig, Teachers College, Columbia University.

11:00 *The Evolution of the Elementary Science Program in Cleveland.*
Mary Melrose, Supervisor of Elementary Science, Cleveland, Ohio.

11:30 *Science Preparation for Those Who Will Teach in Grades 1-6 in Massachusetts.*
W. G. Whitman, State Teachers College, Salem, Mass.

12:30 Luncheon at Curtis Hotel.

AFTERNOON SESSION, 1:30 O'CLOCK

1:30 Annual Business Meeting of the Council.

2:00 *Some School Gardens in Germany.*
Claudia Schmidt, Assistant Supervisor of Nature Study and Gardening, Springfield, Mass.

2:30 *School Garden Activities Related to the Elementary Science Instruction in the District of Columbia Public Schools.*
Esther Scott, Teacher in Charge of Elementary Science and School Gardens, Washington, D.C.

3:00 *The Philosophy of the Teacher of Elementary Science.*
W. C. Croxton, State Teachers College, St. Cloud, Minn.

3:30 *Talking Pictures in Elementary Science.*
V. C. Arnspiger, Director of Research, Erpi Picture Corporation, New York City.

At the recent annual meeting of The Science Association of the Middle States, The Association voted to adopt SCIENCE EDUCATION as its official organ. This action will not only provide for the Association a medium of publication for its proceedings and papers but will also assure the readers of the journal a wider variety of articles relating to the teaching of science.

A new section of the Central Association of Science and Mathematics Teachers has been organized for teachers of science in elementary schools. The first meeting was held in Cleveland, Ohio, on November 25, 1932. Dr. Otis W. Caldwell, Miss Mary Melrose, and Dr. Gerald S. Craig were the speakers. Over one hundred paid memberships were credited to the section.

The officers for the new year are:

Chairman—Ellis C. Persing, Western Reserve University.

Vice-Chairman—Bertha M. Parker, University of Chicago.

Secretary—Florence G. Billig, Detroit Teachers College.

The Engineering Foundation of 29 West Thirty-Ninth Street, New York, has recently issued a pamphlet, entitled "Engineering—a Career—a Culture," prepared by the Education Research Committee of the Engineering Foundation with the active coöperation of groups in six national engineering societies. A review of this pamphlet will appear in a later issue of this journal.

The Clay-Adams Company is now located in new and larger quarters at 25 East Twenty-sixth Street, New York (corner of Madison Avenue), with an entrance also at 20 East Twenty-seventh Street, where they are prepared to render even better and faster service in providing for one's needs. The display room shows in a comprehensive manner a complete line of models, specimens, preparations, slides, charts, et cetera, for visual education use in Botany, Physiology, Anatomy, Zoölogy, Embryology, et cetera.

The collection in the museum is under the direction of L. Alfred Mannhardt, formerly Associate Professor of Biology at New York University, and is open daily during business hours.

The New York City office of Borden's Farm Products Company announces, through its Bureau of Nutrition, that special health educational material of value in science instruction may be obtained by addressing the Director of the Bureau at 110 Hudson Street. All of this material is distributed free of charge to schools in the vicinity of New York.